• CANCER RISKS FROM POWER LINES? • ENGINEERS AS IDEALISTS • SDI's FALSE STARTS •

Technology Review

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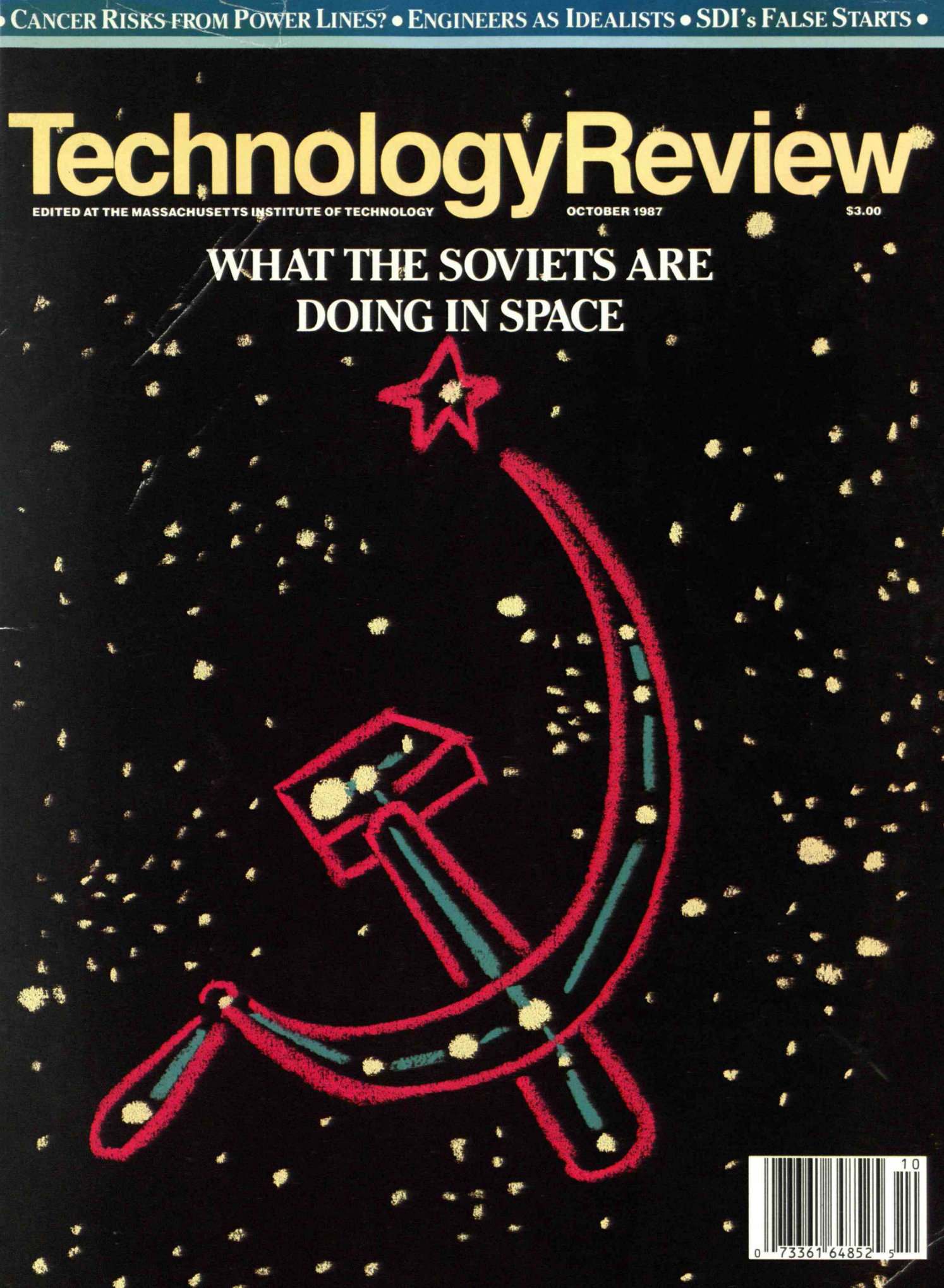
WHAT THE SOVIETS ARE DOING IN SPACE



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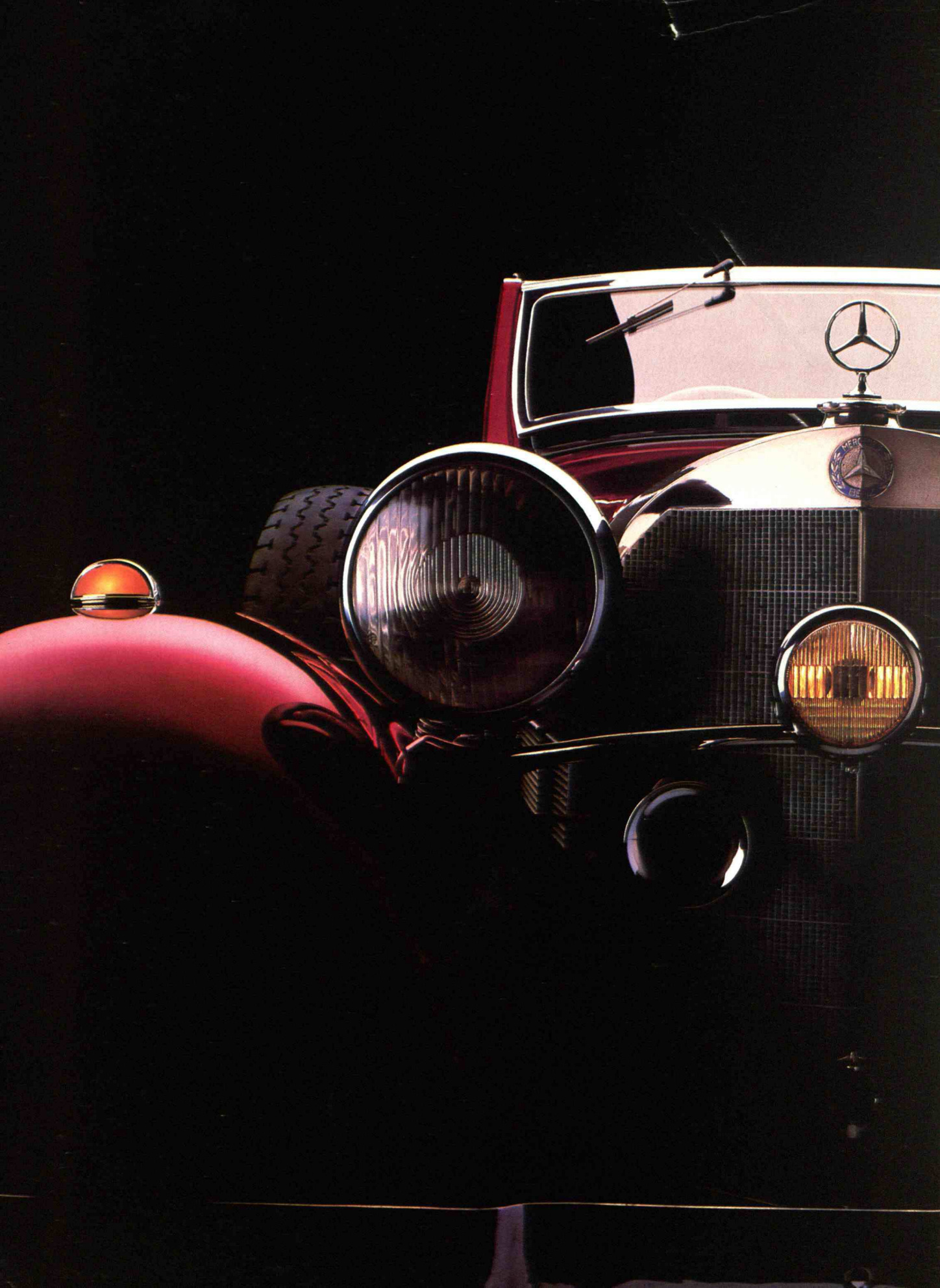

THE MERCEDES-BENZ S-CLASS: THE ONE THING MORE IMPORTANT THAN THE TECHNOLOGY INSIDE IT IS THE TRADITION BEHIND IT.

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The Mercedes-Benz impulse to engineering masterstrokes marks the S-Class in other ways as well. In a body design that brilliantly combines large dimensions and low aerodynamic drag. In handling agility that large sedans have seldom aspired to, much less achieved. In vital technological innovations—an Anti-lock Braking System (ABS); and a Supplemental Restraint System (SRS) with driver's-side air bag and knee bolster, and emergency tensioning retractors at both front seat belts – that are gradually being emulated by other large sedans.

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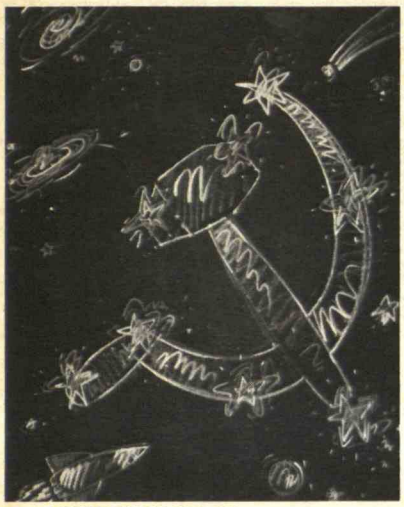

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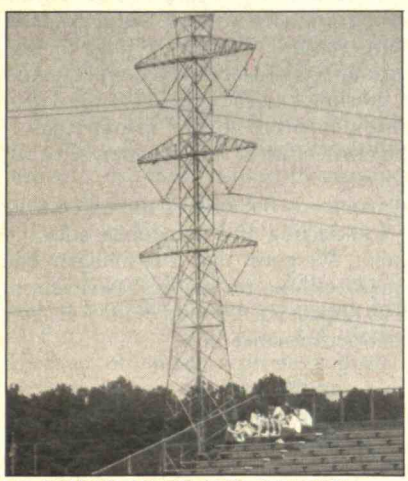

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FIRST LINE

FROM THE EDITOR

Forecasting the Headlines

FOR readers of *Technology Review*, there need have been no surprise in the Environmental Protection Agency's midsummer report that it had found radioactivity from radon in far more homes than previously estimated. Readers will recall the warnings of Anthony V. Nero, Jr., in "The Indoor Radon Story" in January 1986. "The risk from indoor radon is typically thousands of times larger than that from other more notorious environmental pollutants," wrote Nero. "In fact, millions of Americans are exposed to more radiation in their own homes than underground uranium miners experience."

Not everything in this magazine need anticipate the headlines: there is place here, too, for philosophical pieces such as Samuel Florman's essay on the ideals of engineers (*page 18 of this issue*). But the *Review*'s focus on technology-based policy issues should bring us into frequent congruence with headlines that suggest issues at the top of the country's agenda.

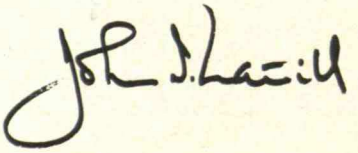
And so it has been, to a remarkable degree, during the last six months.

Essentially all the arguments cited by the Federal Communications Commission for its recent abandonment of the Fairness Doctrine were previewed by Hugh Carter Donahue in the November/December 1986 issue.

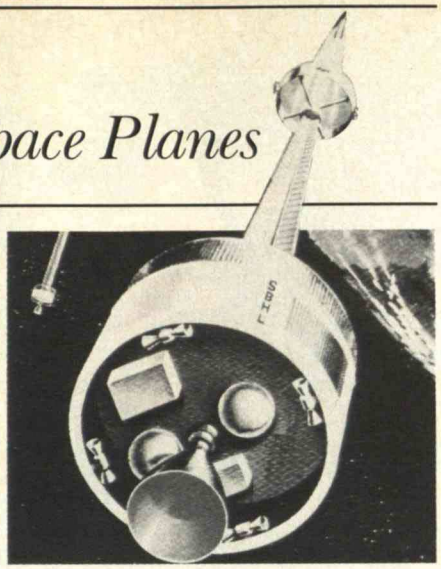
To better understand the USSR's recent overtures for nuclear disarmament in Europe, see Michael MccGwire's "Why the Soviets Want Arms Control" in February/March 1987. And for background on continuing U.S. negotiations with Pakistan over the issue of nuclear proliferation, see "Stemming the Spread of Nuclear Weapons" by Marvin Miller in August/September.

Soviet space successes, described in this issue by Peter Pesavento, are a major motivation for the reassessment of the American space program recently requested by the White House of its Office of Science and Technology Policy. This issue's report on the SDI program by Peter Clausen and Michael Brower explains the motivation behind the major SDI experiments—including attempted missile interceptions and new satellites to track missiles—the Department of Defense has proposed for the next five years. Clausen and Brower suggest an alternative SDI program for the balance of this decade that may well preview the platforms of some 1988 presidential candidates. Louis Slesin's article was revised during editing to incorporate results from a New York Department of Health report, released in July, on the health effects of electric power lines. And the timeliness of the articles on air safety and low-intensity conflict in our August/September issue is surely apparent to all readers.

Currency is but one of the criteria we use in selecting and scheduling editorial content. We guess that it is similarly one of many criteria for readers' satisfaction. In this respect we're proud of the *Review*'s recent performance.



Hippos and Space Planes



AMBIVALENCE ON ARMS CONTROL

In his interesting and valuable article "Why the Soviets Want Arms Control" (*February/March 1987, page 36*), Michael MccGwire makes the point that the Soviets have consistently sought arms control while Americans have been deeply ambivalent. Mr. MccGwire basically states that it has been left to the Soviet Union to draw attention to the portentous consequences of putting weapons into space, while the U.S. debate focuses largely on matters of cost and feasibility. He contends that there is no significant Western debate on opening the Pandora's box of arming space.

While Mr. MccGwire's overall point is well taken, he overstates the case. Scientists in the United States and other Western countries have pointed out—in some cases for the first time—many of the serious consequences of putting weapons in space. Furthermore, debate on this subject is growing rapidly in the United States.

CAROLINE L. HERZENBERG
Argonne, Ill.

Mr. MccGwire's article should conclude, "The Soviets are willing to negotiate significant reductions in strategic nuclear weapons so they can exploit, with impunity, their superiority in conventional arms." This would at least attribute some understandable objectives to them. The expression "Beware of Greeks bearing gifts" might apply here.

DAVID W. SZELOWSKI
Denver, Colo.

The author responds:

The activities Caroline Herzenberg refers to deserve credit. But they involve a tiny minority of the science policy community, and the issues these people have raised are not prominent in the U.S. debate.

The key to David Szelowski's thinking lies in his reference to "understandable objectives." He finds it hard to understand that avoiding world war is a first-order Soviet objective—and that invading Western Europe isn't.

The dictum "better safe than sorry" has cost us and the rest of the world dearly, as European electorates are learning. There is, of course, a propagandistic element to the new pronouncements coming out of Moscow. But they also reflect a clear appreciation of what security must be like in a world full of interdependent nuclear powers. Such an appreciation is sadly lacking in those who remain obsessed with the image of a Soviet threat that crystalized between 1948 and 1953.

HIPPO IDENTITY CRISIS

"What's New at the Zoo?" by David M. Kennedy (*April 1987, page 66*) features a photo (page 72) whose unfortunate caption inspired me to write the following poem:

These clumsy hippopotami
May be wondering, individually,
"What am I?"
But to think for a moment
that any of them could be a rhinoceros
Is absolutely prepoceros!

(With apologies to Ogden Nash)

J.I. STEINFELD
Cambridge, Mass.

Steinfeld is right—those are hippos. But this poem is almost reward enough for the editors' embarrassment.—Ed.

SPACE PLANE SHORTCHANGED

In "Will the Aerospace Plane Work?" (*January 1987, page 42*), Stephen Korthals-Altes does not discuss the technologies required for air-breathing ascent to orbit. Nor does he clearly note the differences between those technologies and the ones necessary for cruising at six times the speed of sound.

Korthals-Altes also fails to distinguish between the near-term goal of determining whether an aerospace plane would be technically feasible, the intermediate-term goal of building a prototype, and the distant prospect of operational aircraft. Specifically, he attempts to cast doubt upon the government's cost estimate for the prototype by invoking his own cost estimate for the operational craft. And in using the

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CONTINUED FROM PAGE 5

plight of supersonic transports to argue that the aerospace plane is not commercially viable, he betrays a 1971-vintage understanding of some very important technology.

T.A. HEPPENHEIMER
Fountain Valley, Calif.

I am not in total agreement with Stephen Korthals-Altes about the aerospace plane. Although the vehicle will not soon make money or significantly enhance a particular military mission, it will keep the United States at the forefront of aerospace technology. Most of the questions that the author asks are valid, and their importance justifies research to answer them. I believe that the government should develop this aircraft as a research project that is beyond the resources of commercial companies and the capabilities of present technology. If we don't take this risk we will be committing technological suicide. The commercial side should then do what it does best—take this new technology and make it cost-effective.

BYRON K. LICHTENBERG
Wellesley, Mass.

The author responds:
Reader Heppenheimer correctly notes that I touched on only one critical set of issues relating to the technological riskiness of the space plane. Certainly there are others.

My estimate of $17 billion for developing the plane does not reflect the price of operational aircraft. Each would cost an additional $2 billion. Moreover, with but one exception, supersonic transports happen to face roughly the same obstacles to commercial viability that they did in 1971. The only significant development has been the finding that 1970s studies exaggerated the extent to which such craft diminish the ozone layer.

Mr. Lichtenberg's protestations notwithstanding, no one is asking the aerospace plane to be a money-maker in its first few years. But if it is to make money at some point, realistic projections of the cost to develop, manufacture, and operate it must be made at the outset, and nothing of the sort has happened so far.

GUN HISTORY

In his review of *The Social History of the Machine Gun* (*January 1987, page 74*), William Rosenau is wrong to say that U.S. military leaders were more receptive to new technology than their European counterparts. Hiram Maxim, who invented the machine gun, was unable to convince the American military establishment that his new weapon was really useful. It was manufactured in European plants for European armies long before it was made in this country.

I also object to Rosenau's statement that "as the United States learned in Vietnam, mere hardware and sheer firepower do not guarantee the success of a military operation." In mid-1975, when Congress eliminated material aid to South Vietnam, the consequences were severe. As soon as the ammunition and spare parts ran out, the South Vietnamese collapsed before their well-equipped enemies.

THOMAS CACECI
College Station, Tex.

The author responds:
While it is true that the machine gun was manufactured in Europe before it was made in the United States, European military leaders were not necessarily more receptive to the new weapon. A mere four years before the outbreak of the First World War, General Allenby of the British Army complained, "I do not think we make sufficient use of the machine gun. The weapon is not properly understood, and I think that, whether in fire tactics or in the tactical use of the weapon, we have hardly yet made a beginning." Allenby and the other supporters of the machine gun were not heeded and, as John Ellis's book makes clear, it took years of bloodshed before the aristocratic officers of Europe were willing to acknowledge the weapon's revolutionary nature.

I am a bit taken aback by Mr. Caceci's reaction to my remarks about the war in Vietnam. To me the lesson that firepower alone does not ensure victory seems fairly obvious; I think a good number of our military leaders have come to the same conclusion. Much of the American people's frustration about the war could be traced to the fact that hundreds of thou-

Continued on page 78

Archeology's Dating Game

Fast evolution—if not quite revolution—is the order of the day among scientists clocking the early history of human development. Over the last two decades, several techniques have begun to fill in a million-year gap in dating the past.

The gap had existed partly because the most widely used technique—the carbon-14 method—does not work reliably on objects that have been around longer than about 50,000 years. Accurate to within 100 years at the 15,000-year level, traditional carbon-14 dating has another disadvantage. It consumes a lot of the object.

The method is based on the fact that radioactive carbon 14 in living creatures starts to decay when they die. By measuring the proportion of carbon 14 to its decay products, researchers can determine a sample's age. Since carbon 14 loses half its radioactivity every 5,700 years, after about 50,000 years too little of it remains to measure accurately.

Near the million-year mark, scientists can take advantage of a geological coincidence to start clocking once more. Early humans evolved in an area of Africa with active volcanoes. This lets "geoarcheologists" date bones using radioactive potassium 40, which is generated in eruptions and has a half-life of over a billion years.

The most important new clock filling the gap between the two methods is accelerator mass spectrometry (AMS). The technique refines carbon-14 measurements by using particle accelerators built for nuclear-physics research.

The principle of AMS is simple. Atomic particles in a sample are given an electric charge so that they can be accelerated. This makes it possible to separate the particles based on their weight. The AMS detectors are so accurate that each carbon-14 atom is counted. AMS theoretically can date objects 75,000 years old. Just as important, AMS picks up minute amounts of carbon 14 and hence requires only a tiny piece of an artifact.

The most spectacular result of AMS has been re-dating a scraper known as the "Old Crow flesher." A conventional carbon-14 test said this tool from Canada's Yukon was 27,000 years old, dating from before the most recent Ice Age. Scientists doubted that people were in North America that long ago, but conducting another test would have meant destroying all that remained of perhaps the oldest tool on the continent. AMS permitted a new analysis, which revealed that the controversial scraper is only 1,350 years old.

Because of its conservative quality, AMS will be used this year to date the Shroud of Turin, the cloth in which Jesus was allegedly buried. Six samples will require 120 milligrams of the shroud. Before AMS, a handkerchief-sized piece of material would have been needed for each test.

Forward to the Past

Another new technique that extends scientists' reach counts the electrons from cosmic rays and natural earth radiation. After an organism dies, these particles gradually fill all the defects in the atomic structures of teeth and bones—a process that takes from 400,000 to over 1,000,000 years.

Scientists have been experimenting with ways to empty the electrons out and count them to determine an object's age. Some researchers heat the material and measure the light flash produced by the accumulated electrons. David Huntley and Dorothy Godfrey-Smith at Simon Fraser University in Vancouver, British Columbia, dislodge the electrons with a laser.

Henry Schwarcz and Rainer Gruen of McMaster University in Hamilton, Ontario, count electrons indirectly in an electron spin resonance (ESR) spectrometer. They have preliminary evidence that early humans in Israel were technologically backward. Using ESR the researchers have dated teeth found together with tools in a cave near Nazareth. In Europe the tools are associated with

Scientists are finding new ways to date old objects, including European cave paintings (below) and the Shroud of Turin (inset), Jesus' alleged burial cloth.

PHOTO: HENRY P. SCHWARCZ, McMASTERS UNIVERSITY
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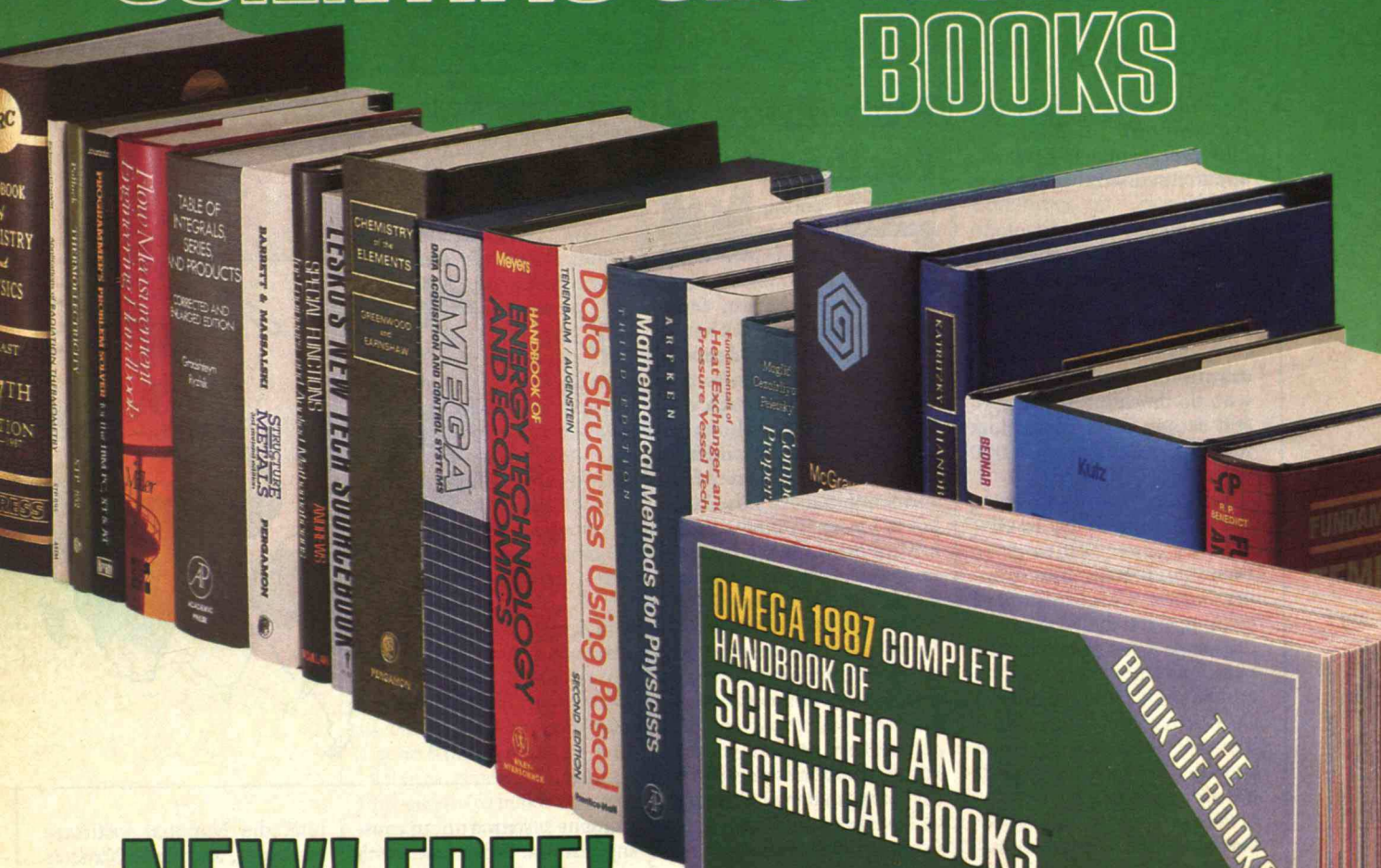

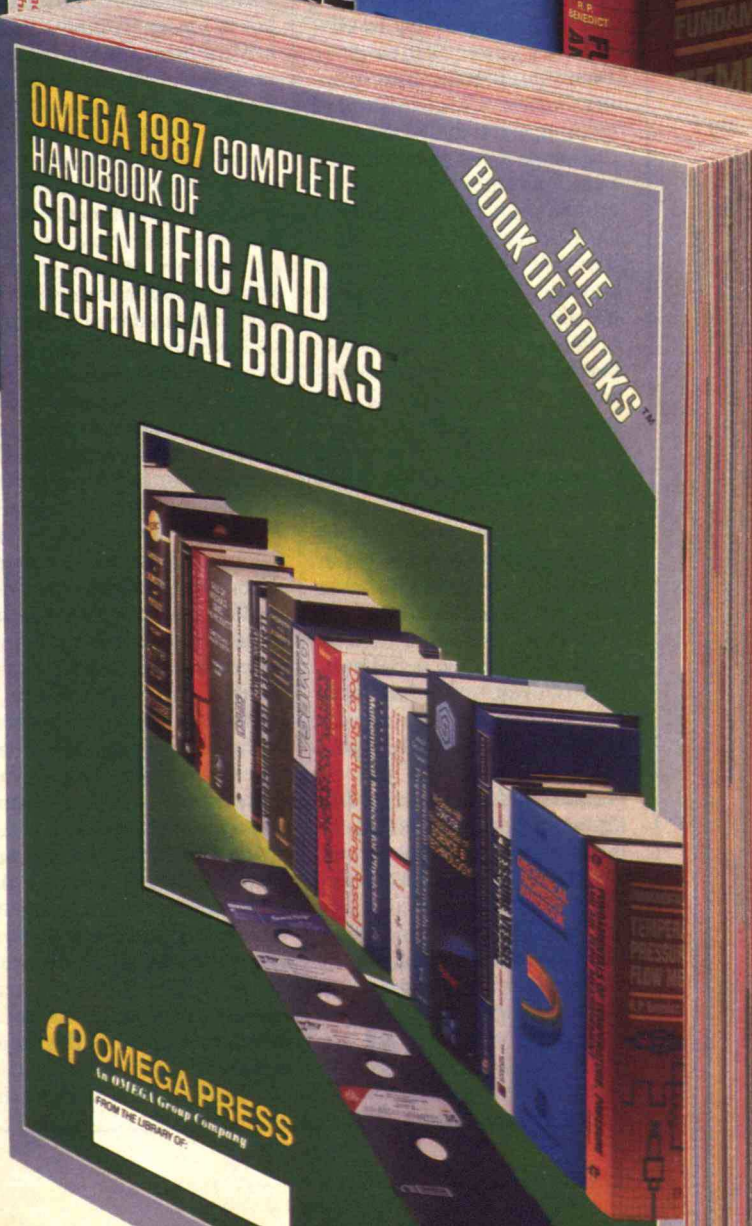

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Neanderthal technology, from about 120,000 B.C. However, people in Nazareth apparently used them around 60,000 B.C.

In another new technique, a simple, physical phenomenon sets the timer. Uranium dissolves in water, but thorium, into which uranium decays, doesn't. A water-borne uranium deposit starts out with no thorium. As the mineral decays, it leaves thorium 230, with a half-life of 75,000 years.

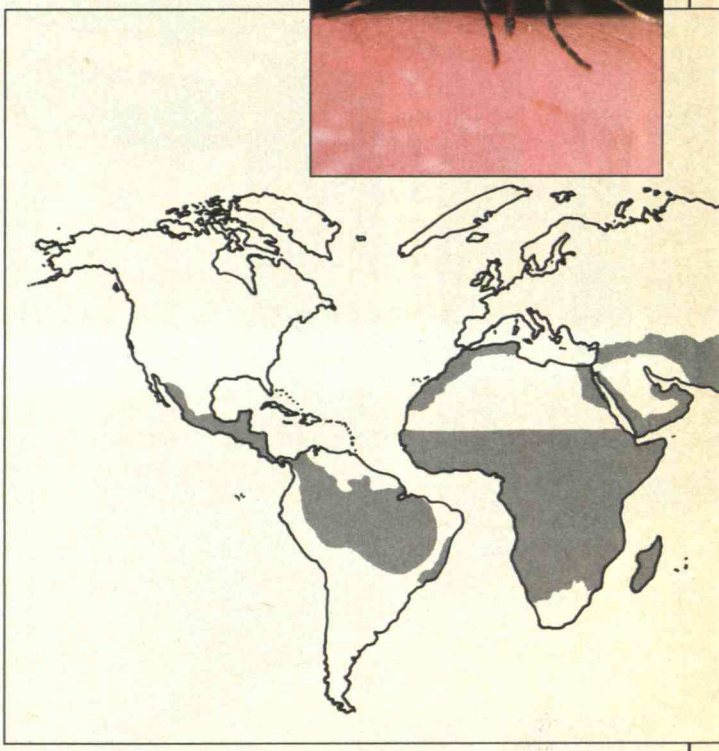
Schwarcz has been using this technique to try to date famous cave paintings in France and Spain. The paintings often were done over drippings on the wall. New drippings occurred after the paintings were completed. By measuring the thorium in slices over and under each painting, Schwarcz hopes to provide an accurate assessment of its age.

Perhaps the most controversial approach to the archeological dating game measures the "directionality" of amino acids in proteins. Chemical processes in living organisms force amino acids to line up in an unstable "left-handed" arrangement. After an organism dies and over perhaps 20 million years, a spontaneous flipping mechanism redresses the imbalance.

However, scientists have learned that the changeover rate depends a lot on temperature and material. Just as carbon 14 failed on the Old Crow flesher, the amino-acid method misdated the arrival of humans in North America. Therefore, this technique is restricted largely to bird eggs and seashells, particularly in the relatively stable climate of the Arctic. □

STEPHEN STRAUSS is a reporter for the Globe and Mail *in Toronto, Ontario.*

Parasite Pacification



Travelers swallow a bitter pill when they visit places like Kenya, Indonesia, or Guatemala. The pill is chloroquine, and one a week usually prevents malaria, a disease that each year infects up to 300 million people and kills up to 2 million. But in parts of West Africa and Southeast Asia the bitter pill is losing its ability to inhibit *Plasmodium falciparum,* the parasite that causes the deadliest malaria.

The most common anti-parasite tactic in the tropics, where *Plasmodium* thrives, is also failing. For decades, insecticides like DDT, dieldrin, and HCH have been used to kill the *Anopheles* mosquitoes that carry malaria. However, mosquitoes are becoming resistant to these poisons.

Between mosquito resistance to insecticides and parasite resistance to drugs, the old tools for fighting parasitic diseases no longer suffice. Biotechnologists may be developing vaccines and drugs that could provide an answer.

When an infected mosquito bites a person, the parasite moves into the bloodstream, heads to the liver where it multiplies, and then enters blood cells to continue growing. When an uninfected mosquito bites an infected person, the cycle starts over.

Vaccines based on the human immune system are the biggest hope of anti-parasite warriors. In the immune system, a parasite infection causes antibodies to form, and the next time a similar infection appears, the antibodies help to get rid of it. A vaccine would stimulate the immune system without causing malaria. When faced with a parasite, the body would be prepared to resist it.

Unfortunately, vaccines for malaria are difficult to develop. Each time *Plasmodium* moves—from mosquito to bloodstream to the liver to blood cells—it has a different form and so requires a different antibody and vaccine. An effective vaccine would attack the *Plasmodium* before it multiplies, on its way to the liver. But only a small amount of the parasite is in the body then, making it hard to get enough material to produce vaccine on a large scale.

Recombinant-DNA techniques may make it possible to manufacture material in the quantities needed. In May, researchers from the Walter Reed Army Institute of Research, the Naval Medical Research Institute, the Biomedical Research Institute, the National Institutes of Health, and Smith Kline & French Laboratories announced that a recombinant-DNA vaccine has given human volunteers some protection from malaria.

The joint study indicates that an effective malaria vaccine is possible, but the research is preliminary, involving only eight volunteers. Vaccines to generate antibodies that are as effective as those from naturally acquired infections are still years off. An interim approach is to make chloroquine-resistant *Plasmodium* once again sensitive. Since these parasites seem to resist chloroquine by actively pushing it out, the idea behind the experimental drug verapamil is to keep chloroquine within the cell walls. Verapamil tested on isolated *Plasmodium* works well, but it has yet to be tried on malaria-

PHOTO: BRUCE COLEMAN, INC.

Insecticides and drugs are no longer enough to keep mosquitoes from spreading malaria. The map shows where the disease is especially prevalent.

stricken animals, to say nothing of people.

Parasite in Hiding

Vaccines for the parasite disease schistosomiasis, affecting about 250 million people, may prove as elusive. Caused by the parasite *Schistosoma mansoni,* the disease often appears first as a rash. Later symptoms may include fever, bloody diarrhea or urine, and liver damage. Some victims die.

Snails infected with *S. mansoni* thrive in slow-moving streams and drainage ditches. An infected snail produces tens of thousands of schistosome larvae that enter people working or playing in the water. The larvae go through the skin into the bloodstream, traveling first to the liver. In a few weeks they move to the outside of the intestinal wall, where female schistosomes release about 3,500 eggs a day that can get into the intestine and feces.

People with schistosomes take praziquantel to kill the parasites directly, but the drug does not assure that a person will stay schistosome-free. Reinfection occurs because schistosomes can "hide" from antibodies. The adult worm cloaks itself with human proteins and is invisible to a person's immune system, so a past infection doesn't provide protection. Some data even indicate that antibodies a person produces to kill schistosomes actually protect the parasite somehow.

Nevertheless, using biotechnology, French researchers have made steps toward a successful schistosomiasis vaccine. They have combined a gene from *S. mansoni* with bacterial genes and induced the bacteria to make a protein that is part bacterial and part schistomal. The rationale is that even if a whole schistosome is invisible, the bacterial part of this hybrid protein will stimulate the immune system. Rats and hamsters vaccinated with the mixed protein are protected from live schistosomes, but the vaccine still hasn't been tried in humans.

Even vaccines won't eliminate parasite diseases. Long after technology devises a therapy, political and economic roadblocks could hinder treatments. For example, chloroquine costs only 7 cents per person per year, but transportation and personnel cost 95 cents. Treating 1.4 million Brazilians for schistosomiasis took 397 workers, 35 vehicles, 23 motorcycles, 100 bicycles, and a few mules. □

JULIE SCHECTER is a freelance science writer.

Monumental Corrosion

The green crust or patina on bronze and copper statues is a product of corrosion, but one that pleases many modern eyes. Yet even those who like patinas are worried these days. Environmental changes are producing corrosion crusts that are increasingly susceptible to air and wind erosion. On outdoor sculpture, erosion can mean the loss of significant detail. Conservators, corrosion engineers, and atmospheric chemists are looking into the causes of the damage and how to treat it.

Copper often forms a relatively stable copper-sulfate crust called brochantite on statues. But acid deposition may be creating another copper sulfate called antlerite, which has been spotted on many outdoor monuments. Because antlerite is more soluble in water, it can cause copper to wash off faster.

Besides acid rain, acid deposition includes acid snow, which may leave rivulets as it slowly melts, and dry acidic particles that can pit a statue when they become moist. Moreover, gases such as sulfur dioxide and nitrogen oxides can reach areas on a monument that acid rain or snow doesn't, and their effect can be just as damaging.

The Statue of Liberty has antlerite that seems to have many sources. In addition to acid rain, "dry deposition from power plants in the Manhattan area that burn high-sulfur fossil fuel and severe weather patterns from the Northeast that cause erosion have resulted in a more aggressive environment," says Robert Baboian, chairman of the National Association of Corrosion Engineers' Committee on Conservation of Artistic and Historic Works.

Changes in air-pollution laws and the increasing use of low-sulfur fuels have cleaned the environment in some areas. But conservator Andrew Lins of the Philadelphia Museum of Art cautions that the changing mix of pollutants means that different chemical reactions occur, which may not be beneficial for a statue.

To address such issues, the National Park Service, which is responsible for maintaining thousands of outdoor monuments, is participating in a National Acid Precipitation Assessment Program. One study at Gettysburg National Military Park in Pennsylvania is measuring surface loss caused by rainfall. Rain that has reacted with late-nineteenth-century bronze plaques and statues is compared with rainwater that has not fallen on the monuments. Also, researchers gather air-quality samples weekly to analyze the concentration of various particles and gases. Unfortunately, in 1986, the first year of the study, too few rainfalls occurred for conclusions to be drawn.

Curing Corrosion

While research into the causes of degradation goes on, conservators are trying to repair damage that has already occurred. Treatments vary widely.

At one end of the spectrum, says Baboian, are conservators who say that the patina on bronze serves no protective function and should be totally removed. They inves-

MAP: WENDY SIMPSON

Left: Dirt and corrosion used to cover Abraham Lincoln's statue in Philadelphia's Fairmount Park. Right: In 1983 conservators treated the monument.

tigate the artist's intentions for the surface appearance. Based on this research, the statue or monument is repatinated, sometimes with a blowtorch and chemicals. Then conservators often protect the piece with Incralac, an acrylic coating, and wax.

At the other end of the spectrum are methods that do not remove the patina. When conservator Steven Tatti was faced with a streaked and pitted bronze statue of Abraham Lincoln in Philadelphia's Fairmount Park, he used pressurized water to clean off the surface dirt that holds harmful pollutants. Next, he heated the sculpture with propane torches to drive out moisture. Finally, he added a protective coating, working hard paste wax into the surface with more heat and brushes.

A few statues—like the four horses of the basilica of San Marco in Venice—have been moved indoors to prevent further corrosion. But this solution is generally impractical, given the size of many monuments. It is also expensive, and money is a problem in art conservation. Many localities cannot guarantee continued funding for maintaining outdoor statues.

To direct spending toward preserving irreplaceable artworks, some conservators have taken to politics. During the 1983 Acid Rain Awareness Week in Massachusetts, conservator Arthur Beale of Boston's Museum of Fine Arts accompanied state officials and the press on a walking tour of damaged Boston monuments. He has maintained that conservators must go beyond treating individual works and engage in a national effort to root out the environmental causes of deterioration. "We will have to become voices with the media and with legislators," he told a 1983 conference on outdoor sculptural monuments at the Philadelphia Academy of the Fine Arts.

Four years later, no federal legislation has passed, but five states in the Northeast and Midwest have enacted statutes that require reducing the sulphur dioxide emissions that contribute to acid deposition. Awareness of the danger to statues may have helped get those laws on the books, Beale believes. "The issues surrounding outdoor art are much more in the public view," he contends. □

KAREN ROSENBERG writes frequently on the politics of culture.

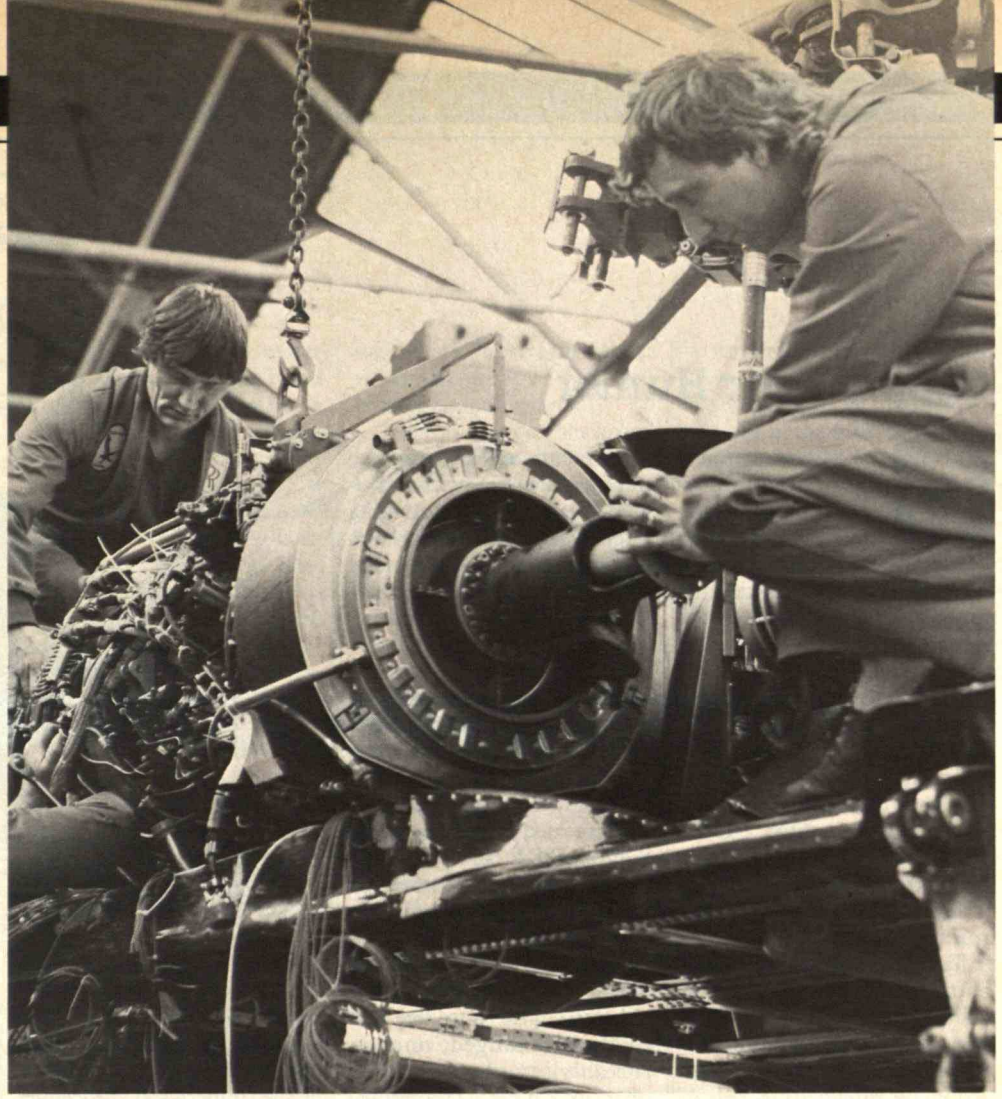
London's Technology Networks

A nondescript building in south London houses one of Britain's most productive experiments in alternative uses of advanced technology. The Greater London Enterprise Board (GLEB) has mobilized the city's technical resources to design and develop profitable, innovative products that meet social needs while saving and creating thousands of jobs.

GLEB began in 1983 as an outgrowth of the commitment of the local governing body, the Greater London Council, to solving the city's economic crisis. Over three decades, London had lost two-thirds of its 1.5 million manufacturing jobs, while the growth of service jobs had done little to reduce the unemployment rate. The council wanted to focus on developing products—such as inexpensive and non-polluting transportation and energy systems—that would enhance the quality of life and provide jobs.

GLEB hired Mike Cooley to direct its technology department. An engineer who had spent 20 years in the aerospace industry, Cooley had helped write the well-known Lucas Corporate Plan for converting Britain's largest aerospace manufacturer from military to civilian production. With a budget of £32 million, GLEB has established five technology networks in London linking academic researchers with workers facing lay-offs and community groups seeking services. These networks develop prototype products, and GLEB

PHOTO: FRANKO KHOURY



Rolls Royce's Leavesden plant near London will house a computer system that encourages creative exchanges between designers and production workers.

helps start cooperative, public, or private enterprises to make them.

The networks now maintain a computerized database of some 1,500 product ideas, on many of which they hold a patent. They make the ideas available to groups that will manufacture the products to prevent plant closings or to open new enterprises. The products range from energy-saving central-heating controls and low-cost domestic heat pumps to robots for use in schools to electric vehicles for airports, mines, and docks. A GLEB project has produced a state-of-the-art scientific workstation, an advanced personal computer used for design and engineering tasks.

GLEB's technology department has also set up Britain's first "design surgery," modeled after medical and political surgeries. In Great Britain, the medical surgery is the room in which doctor and patient consult. In the design surgery, engineers and design engineers meet two nights a week with community residents to discuss and solve development problems. One notable outgrowth of the surgery is an advanced motor that can be used in city transportation, small boats, and wheelchairs. In addition, the surgery has helped start a company that produces innovative refrigeration plants.

Through such projects, GLEB has saved or established 200 companies and 4,000 jobs. The cost of each job created through GLEB comes to "about £4,700," Cooley says. By comparison, "an unemployed worker with two dependents costs the state £7,000 per year."

Part of GLEB's philosophy is that new technology should enhance workers' jobs and skills. "We were very concerned with reports—particularly those that came out of the United States—that said the ideal workers for numerically controlled machine-tool systems were either mentally retarded or had the mental age of 12," Cooley notes.

By contrast, GLEB seeks to develop what Cooley terms "human-centered" computer systems. "Human beings handle the qualitatively subjective judgments that they are so good at making, while the machine deals with the quantitative elements," he explains.

The European Economic Community's (EEC) "Esprit Project," in which GLEB is participating, illustrates the concept. This collaborative venture has nine university and corporate partners in Great Britain, Denmark, and West Germany, including two of Britain's largest companies, British Insulated Calendar Company (BICC) and Rolls Royce.

Esprit is developing a prototype computer manufacturing system that could be applied to a number of types of factories. The first part of the system will be installed at Rolls Royce's Leavesden plant near London next year. The project's computer-aided design component will provide a two-way link between production workers and designers. They will be able to transmit sketches to one another and electronically interact "in a creative way," says Cooley.

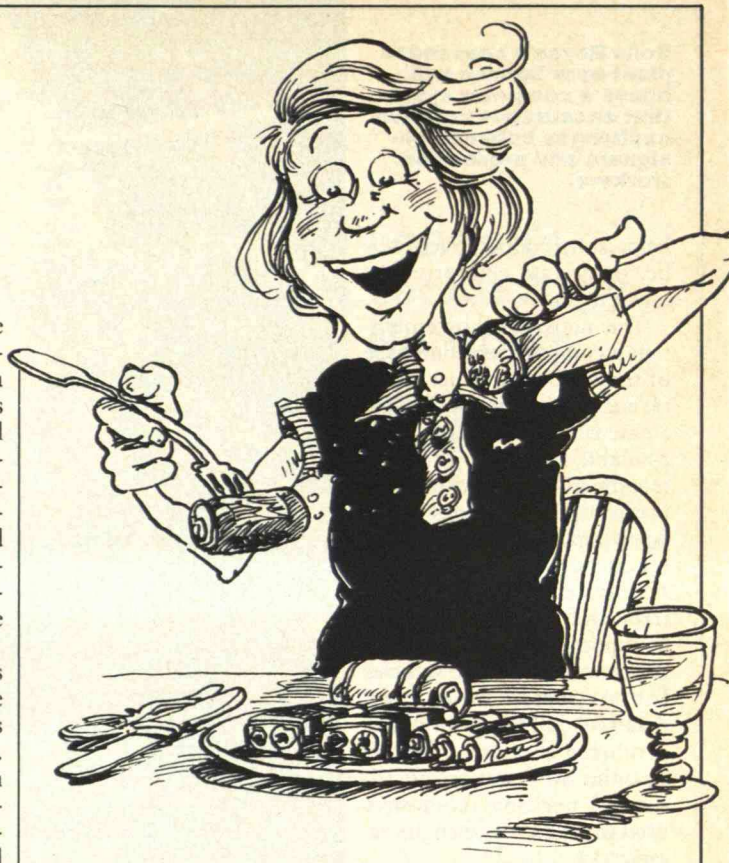
GLEB's technology department also participates in a three-way EEC network with the Basque provinces in Spain and the Greater Brussels municipal government. Via computer, the partners trade information about products designed and developed in their respective areas. They make this information available to firms, helping minimize R&D costs. As a result, a London company produces large-scale refrigeration systems developed in Belgium, and a German-Belgian company produces composite tires developed in Britain.

Such contributions allowed GLEB to survive the 1986 demise of the Greater London Council, its primary funding source. Legislation introduced by Margaret Thatcher's Conservative Party abolished England's five metropolitan councils, leaving London and four other cities without local government. GLEB received replacement funding from London's boroughs, Britain's Department of the Environment, and the EEC. □

SUZANNE GORDON writes on labor and technology and other work-related issues.

PHOTO: ROLLS ROYCE LIMITED

Hippocratic Humor



One of the nation's most prestigious medical journals once reported that "Classic" Coke kills sperm better than "New" Coke. The same journal ran a whole series of explanations for why birds attack joggers.

It's right there in the *New England Journal of Medicine*. Beyond the case reports and research findings lurks a section in which the articles all begin "To the editor." Generally the letters are "a mixed bag," says Mary Suda, an editorial assistant at the respected *Journal*.

Take the case of the low-battery diet. Munro Proctor of Concord, N.H., wrote about a patient with abdominal pains. After doctors had a difficult time getting a clear electrocardiogram (EKG), an X-ray revealed five AA batteries in her stomach. The batteries were surgically removed, and the patient is now doing fine. Proctor noted in his letter that an EKG worked when the patient, a paranoid schizophrenic from the state mental hospital, swallowed only a spoon or one battery.

Sometimes the correspondence contains research findings from unusual experiments. The letter entitled "Effect of 'Coke' on Sperm Motility" was "a lark," says co-writer Deborah Anderson, an associate professor of obstetrics and gynecology at Harvard Medical School. "I had a fellow in the lab who heard as a teenager that Coke was used as a post-coital contraceptive," she remembers. When the topic came up in the lab, it led to a three-hour experiment.

The research team mixed soft drinks with semen samples in test tubes. After one minute, the scientists evaluated sperm motion through a microscope. Diet Coke was declared the best spermicidal soft drink, although the authors do not recommend using it or any cola for contraception. The report attracted wide attention, leading to radio interviews aired in Brussels, Australia, and elsewhere around the globe.

Among the strangest letters Suda recalls, aside from those the *Journal* doesn't print, was a martini-toothpick warning. A man had downed a Gibson cocktail and the accompanying onion. Then, says the report, "the toothpick floated from the glass into the oral cavity and lodged, uncomfortably, in the posterior pharynx." That is, the toothpick got caught in the back of his throat.

While attempting to dislodge the toothpick, he coughed it up into his nose. Finally, a doctor at a hospital emergency room removed the toothpick with a forceps. The authors of the letter, including the victim and the doctor, point out that this hazard should be recognized when imbibing martinis as well as Gibsons.

True Stories

Right alongside the less serious letters are those about antibiotic side effects, medicare payments, smoking hazards, hepatitis, and removing cockroaches from the auditory canal.

Cockroaches?

Kevin O'Toole got the opportunity to perform a "controlled" auditory-cockroach-removal study when a woman entered the emergency room of Charity Hospital in New Orleans with a bug in each ear. O'Toole used an old reliable mineral-oil procedure in one ear, and applied lidocaine, an anesthetic, to the other.

While mineral oil was an effective mode of extermination, the dead insect was difficult to remove from the ear canal. After lidocaine treatment, however, the insect exited the ear "at a convulsive rate of speed," wrote O'Toole and his co-authors. A "fleet-footed intern" then applied a "time-tested remedy and killed the creature (which tried to escape across the floor) using the simple crush method."

Like Anderson's letter, O'Toole's generated world-wide interest. In a rebuttal, a Maryland doctor told of a patient who ended up dizzy for about five hours after lidocaine treatment.

Although this follow-up letter was printed, the *Journal* usually doesn't run letters about letters. Perhaps the most notable exception is the bird-attack series. Between December 1984 and November 1985, the *Journal* ran six reports of bird attacks on joggers.

The letters presented a variety of hypotheses to explain the phenomenon. One idea was that joggers were running through birds' nesting areas, but this seemed unlikely since bicyclists were safe. An alternate theory said that the birds wanted hair for nesting materials. Another physician suggested that joggers' perspiration attracted gnats, and that the birds were looking for gnat snacks. Finally, one multiple-bird-attack victim proposed a solution. He attached "eyes" to the back of his cap, noting that birds will not fly at a "facial stare."

Although the bird-attack problem has not ended, the letters have—for now. But undoubtedly, the *New England Journal of Medicine* will continue to provide insight into how to cope with society's problems. □

JONATHAN SCHUSTER is a free-lance science writer.

ILLUSTRATION: JON MCINTOSH

Chip Nerves

A combination of microelectronics and microsurgery may eventually make it possible to restore feeling and use to deadened limbs. Researchers working at Stanford Medical School and the U.S. Veterans Administration Hospital in Palo Alto, Calif., have taken a step toward that goal by growing microscopic axons, or nerve fibers, through tiny holes drilled in silicon chips. Morton Grosser and Joseph M. Rosen envision a time when their invention would lead to an "implantable switchboard" that would redirect nerve impulses cut off because of injuries.

All muscle movement starts when the brain sends a signal through a nerve. When the signal reaches the severed portion of a nerve, it stops—like an electrical signal in a broken wire. It is possible to repair a severed nerve, and for the axons inside it to regenerate. However, the regrown axons no longer make correct connections to their original end organs.

If an electronic device could be inserted in the damaged nerve, it could pick up the brain's signal and redirect it to the proper end organ. The muscle controlled by the nerve would then respond to the brain's command as if the nerve were undamaged. Gregory Kovacs, a graduate student at Stanford, has been working with Grosser and Rosen on the design and fabrication of such a chip for two years.

The technique that Grosser and Rosen have created and patented connects silicon chips with nerve fibers in experimental rats and one monkey. That could lead to "a man-machine interface at the biological level," says Rosen, theoretically making it possible to bridge the gap in severed nerve fibers. When perfected, implanted chips could direct impulses in regrown nerve fibers to the correct organs.

Microsurgical techniques already allow surgeons to reconnect severed nerves about one thousandth of a meter in diameter. But each nerve contains up to 2,000 axons a millionth of a meter in diameter, much too small to be reattached by surgery. Therefore, reattached nerves don't function well and the patient loses almost all motor capacity.

With the axon-chip system, each of 2,500 eight-micron holes in a 1-by-1.5-millimeter silicon chip would be insulated from all others. A neurologist would identify which axons should be linked, and a small pulse of electrical energy would destroy the insulation between the appropriate holes. Thus the chip would link "upstream" axons with the proper "downstream" counterparts.

With so many axons growing through holes in the chips, it would seem impossible to match the severed ends perfectly, even with the help of electronics. Fortunately, an exact connection wouldn't be necessary, Grosser says, because of "redundancy" in the nervous system—that is, many axons transmit similar information simultaneously. "If we get even 20 percent of the axons correct, the odds are very good that we'll get 80 percent or more of the original function. The difference between 80 percent and 100 percent of real function is not discernible to most people."

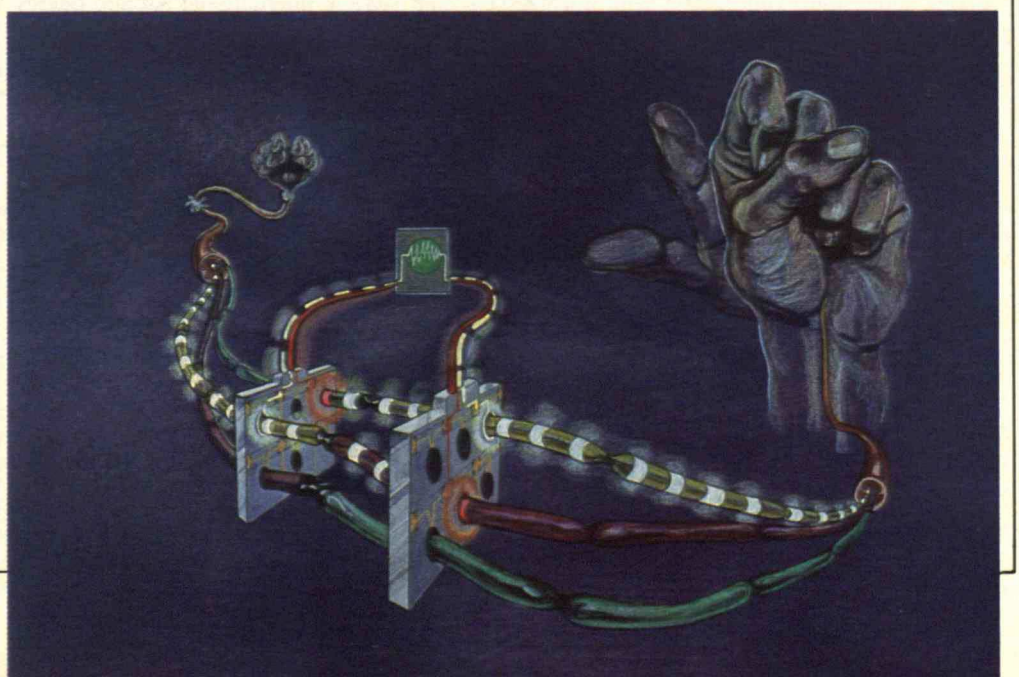
Rosen and Grosser started the project in 1984, and Kovacs joined them the next year. They expect it will take at least five more years to achieve a workable axon processor for humans.

Much more time will be required to realize another vision. Rosen thinks it might be possible to implant one chip in a patient's paralyzed foot and another in a hand where nerves still work. By moving a finger, the patient could transmit electrical signals from the chip in the hand to the one in the foot, so that the leg would move. In effect, he says, it might be conceivable to "let your fingers do the walking."

Grosser points to another possibility: the elimination of the "phantom pain syndrome," in which amputees feel pain in a limb that doesn't exist. According to Grosser, they are getting pain messages from a "reflected synapse" or neural connection. "If we could implant a chip in the stump of an amputated leg, for example, we could block the reflecting synapse. . . . The brain would never know that the pain existed because the synapse that caused it would be gone."

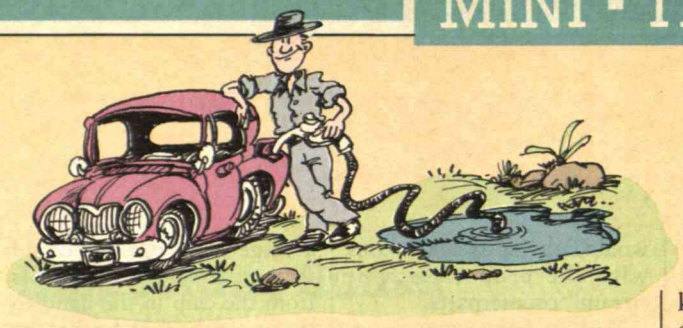
Rosen and Grosser emphasize that such sophisticated applications are years in the future. But their success in growing axons through silicon chips is a vital step. As Grosser says, "If we can get direct access to nerves in human limbs, there is no end to what can be accomplished." □

JOHN MATTILL is editor-in-chief of Technology Review.



Implanted silicon chips could restore connections in severed nerve fibers and make deadened limbs function again.

ILLUSTRATION: © DR. MORTON GROSSER, DR. JOSEPH M. ROSEN



MICROBE FUEL

Plans are underway to produce gasoline and diesel fuels from microalgae ponds by 1989. The Department of Energy's Solar Energy Research Institute (SERI) has signed a $225,000 contract with the California firm Microbial Products to design, fabricate, and operate an outdoor microalgae test facility.

Microalgae are the most primitive members of the plant kingdom. The vast majority exist as single cells in a water habitat. They take in solar energy and efficiently convert it to biomass. Up to 70 percent of the body content of some microalgae is lipid oils that can be converted into gasoline and diesel fuel.

The facility, to be located in Roswell, N. Mex., will grow microalgae whose oil content is high enough to produce up to seven barrels of fuel per acre per week. The Roswell site has been chosen because it offers flat land, lots of solar radiation, few competing land uses, and large reservoirs of salt water.

SDI TAX

From fiscal year 1983 through 1986, 43 states paid more taxes to support the Strategic Defense Initiative (SDI) than they received back in contracts for the military system. The Council on Economic Priorities (CEP), a nonprofit research group, calculated an "SDI tax" based on the personal income taxes paid by the residents of each state and the proportion of federal outlays devoted to SDI.

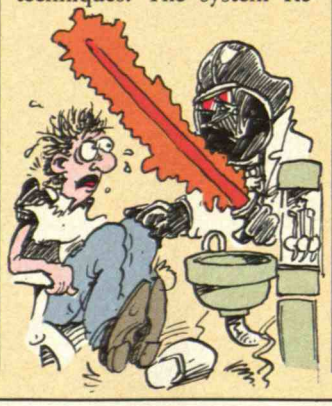
CEP found that 43 states paid 80 percent of all SDI taxes, but received just 14 percent of SDI's economic benefits. By contrast, 7 states and the District of Columbia took in 86 percent of SDI money and paid 20 percent of SDI taxes.

California, New Mexico, and Alabama led the winners, while Georgia, New York, and Illinois fared the worst. Californians paid 12 percent of SDI taxes and got 43 percent of SDI money, for a net "profit" of over a billion dollars. Georgians, on the other hand, paid 7 percent of SDI taxes, or $139 million, and reaped 1 percent of the rewards, worth $8.8 million.

CAD-ENTISTRY

Dentists will soon be able to scan teeth with a laser, then have a computer automatically design and manufacture a replacement crown while the patient waits. Replacement crowns substitute for above-the-gum portions of damaged teeth.

According to Diane Rekow of the University of Minnesota, French, U.S., and Swiss researchers are developing systems that will use existing computer-aided design, image analysis, and computer-aided manufacturing (CAM) techniques. The system Rekow and her associates have created translates photographs of teeth into numbers a computer can analyze. Using software developed at M.I.T., the system provides a three-dimensional image of what a repaired tooth should look like—accurate to 20 millionths of a meter.



The measurements for the part of the crown that caps the tooth come from the tooth itself, says Rekow, who has degrees in mechanical engineering and dentistry. The outside shape of the crown takes into account jaw motion and the tooth's relationship to other teeth. Working from the design, CAM software fashions a program to machine the replacement from metal.

Within a few years, dentists will be able to invest $5,000 in image-collecting equipment and have a central laboratory manufacture the crowns. Large group practices could spend perhaps $200,000 on a full system.

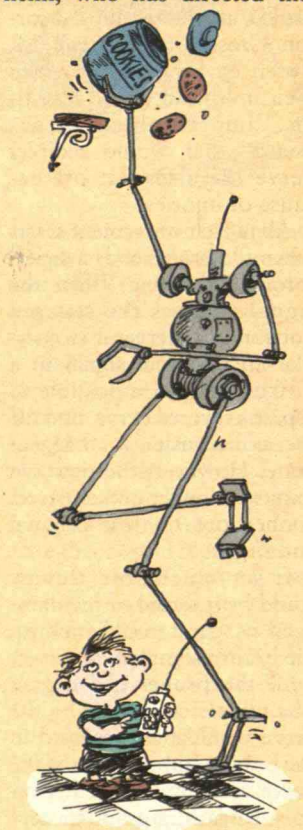
NUKE UNMONITOR

The West German magazine *Der Spiegel* reports that the International Atomic Energy Agency (IAEA) withheld a report chronicling 250 "incidents" at nuclear stations worldwide. According to IAEA spokeswoman Marlene O'Dell, the Vienna-based agency "didn't want to cause a panic."

ROBOT BALANCE

Researchers at Carnegie Mellon University have developed a stick-like robot that simulates human balance. They say their two-wheeled, six-foot-tall prototype is the first that can be trusted to perform tasks in precarious and hazardous environments like a nuclear plant, where it might open valves, inspect pipes, or use welding equipment. Created by graduate student Lyman Petrosky, the robot adjusts its posture 25 times a second in response to kicks, shoves, or changes in its load.

"Our robot can move in the same way that humans do when they move heavy objects by putting their weight into an object, tugging, and pulling," says civil engineering professor Irving Oppenheim, who has directed the



project. This means the robot can assume positions that seem awkward but are needed for certain tasks. For example, a person can balance on one foot to get enough extra height to reach a shelf. "That's what this robot can do with its arm and balancing technologies," according to Oppenheim.

ILLUSTRATIONS: JON MCINTOSH

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Music Of Spain, Vol. 5 Julian Bream, guitar. "Electrifying."—Gramophone RCA *DIGITAL* 114746

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SAMUEL C. FLORMAN

Engineering: An Ideal Profession for Idealists

IN the era of the yuppie, it is good to be reminded that youthful idealism still burns brightly. Although the goal of "helping others in difficulty" is deemed important by a lesser percentage of college freshmen today than in the 1960s, the total number of altruistically motivated young people is still reassuringly high, according to an annual poll by the Cooperative Institute Research Program at the University of California, Los Angeles.

I am disturbed, however, to encounter so many idealistic students who think they can best follow their star through a career of oversight and policing. Ralph Nader is their role model—or else a prosecuting attorney, an investigative reporter, or a crusading politician. These students seem to regard the control of evil as more useful and satisfying than the creation of good. And even where the objective is to help the needy rather than to punish the guilty, their dream is usually to become a social worker or a volunteer for Legal Aid. Very few think of becoming an engineer who might help the disadvantaged in a material way. Too many of our best young people are going to law schools or schools of social work, ignoring the fact that physical need still lies at the heart of most human misery.

Engineering schools compound this problem by preaching a message of pragmatism and steady employment. Thus they lose by default many large-hearted visionaries who, if they fortified their virtue with technical training, could be a tremendous force for good in the world.

With this thought in mind, I was deeply moved to read about the death of Benjamin Linder, the young American engineer who was killed during a battle in the Nicaraguan civil war. Whatever one's politics—and admittedly a good case can be made against the propriety of an American citizen giving aid to the Sandinistas—it is impossible not to have positive feelings about a young person from a well-to-do society assisting the people of a Third World nation. And this was a young person who chose to help not be waving placards in a demonstration, but by bringing his talents to bear against the oppression of poverty.

SAMUEL C. FLORMAN, A CIVIL ENGINEER, IS THE AUTHOR OF ENGINEERING AND THE LIBERAL ARTS, THE EXISTENTIAL PLEASURES OF ENGINEERING, BLAMING TECHNOLOGY, *AND* THE CIVILIZED ENGINEER.

***More** of today's idealists could use technical ingenuity to help the disadvantaged.*

Linder was a 1983 mechanical-engineering graduate of the University of Washington. According to one of his professors, he entered the engineering program specifically to acquire skills that would help him to help others. A friend recalls that "his whole reason for going to engineering school was to go to Nicaragua so he could improve people's quality of life." Linder designed and helped build small hydroelectric plants, and the *Time* reporters who investigated the much-debated circumstances of his service and death concluded that "because of his efforts, the hamlet of El Cua now has electricity." The drama and controversy surrounding the death of this one young man in a remote jungle will have served a worthy purpose if it calls attention to the need and opportunity to blend idealism with technology.

Humanitarian Engineers

There are, to be sure, many engineers who contribute their talents, unheralded, to constructive work in poverty-stricken places, most notably by service in the Peace Corps. And every so often I read of *pro bono* enterprise that warms the heart: engineering students at Northern Arizona University bringing solar-generated electricity to a Navajo reservation near their campus; Purdue students rebuilding sidewalks in the low-income areas of Lafayette, Ind. The Red R (Register of Engineers for Disaster Relief), founded in Great Britain in 1980, maintains a register of British engineers willing to serve from three to six months in areas of urgent need. Its recruits have repaired cyclone damage in Swaziland, helped Vietnamese boat people build camps in Malaysia, and assisted drought victims in Ethiopia. Other assignments include disaster relief in Uganda, Kampuchea, and Sudan. Some of the participants are retired engineers who receive nominal salaries; others are subsidized by their employers or various relief agencies.

A comparable register of engineers was established in Canada in 1982. The American Society of Civil Engineers has established a Task Committee on Response to Disaster Situations; the committee is slated to make recommendations by year's end on how American engineers can contribute in similar ways.

Despite all the good being done, one cannot help but wish that more engineers were inspired by the ideal of humanitarian public service. Equally important, idealistic young people should come to see that many of their most fervent visions of justice can best be furthered through technological assistance to the disadvantaged. The sufferings of humanity cannot be alleviated solely, or even primarily, through politics and litigation. Wherever we look in the world we see material well-being as the essential precondition for democracy and justice. The great challenge for this generation's youth is to direct our technical ingenuity to humane purposes. Toward this end idealists will want to understand the rudiments of technology, and some of them, at least, will want to study engineering. □

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MARSHALL I. GOLDMAN

The Case of the Not-So-Simple Machine Tools

THE U.S. response to the news that Toshiba sold militarily sensitive technology to the Soviet Union seems like a case of Japan bashing. After all, the contract for machine tools totaled less than $25 million.

Indeed, the attack on Toshiba undoubtedly reflects a strong element of anti-Japanese feeling. Public and official anger almost ignores the Norwegian company that was a partner in the deal, as the Japanese again suffer the political consequences of their one-sided trade balance with the United States. The furor about Toshiba's deal with the Soviets comes in the wake of the U.S. decision to impose 100 percent tariffs on a range of Japanese goods. Administration officials explain that move as a direct retaliation to Japan's illegal dumping of computer chips in competition with U.S. companies.

Nevertheless, both Toshiba and Konesberg Vaapenfabrik, the Norwegian firm that sold the Soviets a machine controller to operate the Toshiba equipment, deserve the criticism they are receiving. Neither company innocently exported innocuous machinery. The sale involved espionage and deceit, and ultimately it neutralized the major and unilateral U.S. missile threat to the Soviet Union: a virtually silent and undetectable nuclear-missile fleet.

That fleet is the most important leg of what U.S. strategists call our triad approach to defense. The second leg is the strategic bomber force, and the third is land-based missiles. Some in Congress estimate that it will cost the United States several billion dollars to regain the advantage lost because of the $25 million deal.

However, this exposé is obscuring a very real problem with the system designed to prevent the export of sensitive technology. While corporate greed is a major cause of violations, so too is the U.S. tendency, encouraged by the Pentagon, to over-regulate trade with the Soviet Union and Eastern Europe. That practice breeds widespread, and well-founded, cynicism and disregard for controls.

The story begins in early 1980 when U.S. spy John Walker, Jr., apparently alerted the Soviets to the reason its submarines were sitting ducks for U.S. antisubmarine forces. Once the Soviets knew that the noisy propellers were the cause, they immediately sought to buy milling equipment to fashion quieter ones.

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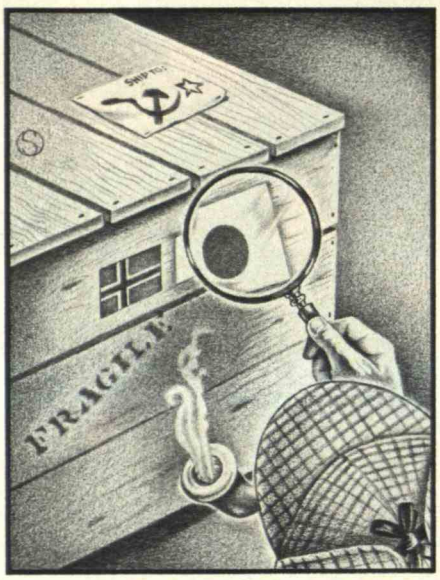

The system to control the export of sensitive technology invites abuse.

KGB agents and representatives of the Soviet Ministry of Foreign Trade quietly approached Wako Koeki, a small Moscow-based Japanese trading company noted for its willingness to cut corners when selling strategic equipment. That company contacted Toshiba Machine, which was producing equipment comparable to that of U.S. submarine builders.

The details were worked out with care. Everything would appear aboveboard. A contract, signed on April 24, 1981, arranged for the sale of four milling machines through Toshiba's traditional trading house, C. Itoh, which has a much more respectable reputation than Wako Koeki. Toshiba then applied to the Japanese government for a permit to export TDP 70/110 model milling machines with two axes to a Leningrad electric power plant. The TDP 70/110 is relatively unsophisticated, and its sale would not attract special notice. Overwhelmed authorities in Japanese customs and the Ministry of International Trade and Industry did not realize that Toshiba actually shipped MBF 110 milling machines, a far more advanced instrument with nine independently controllable axes.

Shortly after Toshiba shipped the machines to Leningrad in December 1981, Konesberg sent Toshiba the software needed to guide the MBF 110 hardware. Konesberg, too, applied for an export permit for a simple model and, when it came time to ship, substituted a more sophisticated one. An unknowing employee of another Japanese company then carried it into the Soviet Union as a personal favor for a Toshiba official. To install and demonstrate the machinery, Toshiba and Konesberg technicians traveled not to an electric power plant, but to Leningrad's highly secret Baltic shipyards.

Clearly, both Toshiba and Konesberg knew that their actions would eliminate what the United States had considered its primary missile advantage over the Soviets. No other single sale has so simply, quickly, and identifiably damaged U.S. military strategy.

Red Lights and Robbers

For the short run, at least, reaction to the sale of the milling machines will cause exporters to tighten their controls. Already Japan and Norway have instituted new methods and committed additional resources to prevent any recurrence. But companies in other nations will probably either ignore or actively subvert the export control system—a system not up to its task.

Central to the existing system is the Coordinating Committee on Multilateral Export Control (COCOM). Based in Paris, COCOM is composed of representatives from NATO, France, and Japan. It is intended to prevent strategic materials from reaching the Soviet Union by establishing minimum guidelines on what may be exported to that nation. For example, COCOM permits the sale of milling machines like the simpler TDP 70/110. In addition to COCOM's guidelines, member nations can impose more stringent export controls, as the United States does through

Continued on page 73

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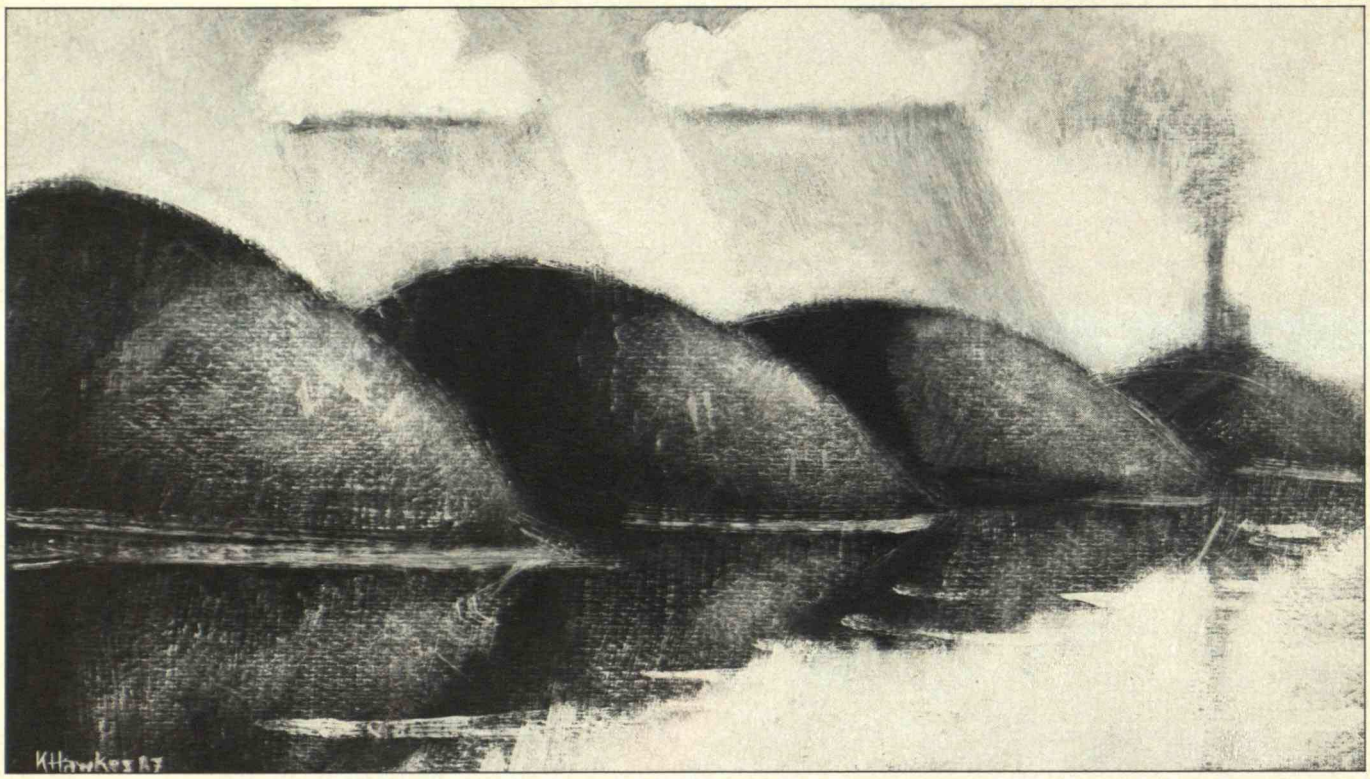
Thai

Royal Orchid Service

BY DAVID L. BOOSE

Needed: A Clean Soil Act



FIFTEEN years ago, the Clean Air Act and Clean Water Act became the foundation of environmental protection in the United States. Unfortunately, by focusing only on air and water, legislators created the impression that once pollutants were out of these media, they would be out of the environment entirely. In fact, although our air and water are now arguably cleaner, our soils and sediments are becoming significantly more polluted.

Pollutants permitted to be discharged under the Clean Air and Clean Water acts may not damage the environment directly via air or water, but they can cause harm after settling and accumulating on soils and the sediments of water basins. Consider acid deposition. Even when the National Ambient Air Quality Standards are not exceeded, coal-burning power plants in the Midwest emit enough sulfur dioxide to acidify soils hundreds of miles away.

DAVID L. BOOSE is a staff scientist for the Toxic Chemicals Program of the Environmental Defense Fund, based in Washington, D.C.

> ***S**oils have been the ultimate dumping ground, but there is no "away," despite our throwaway attitude.*

This can lead to large-scale loss of valued species of forest trees. To protect the soil, we must pass a clean soil act to force us to treat the environment as the complete system that it is.

Regulations pertaining to soils focus primarily on hazardous-waste disposal and cleanup requirements. And these concern only two means of chemical exposure: leaching and volatilization. Leaching occurs when rainwater or snowmelt passes through soils and carries contamination deep into the ground, sometimes to groundwater. Volatilization takes place when a soil contaminant vaporizes into the air.

Yet contaminated soil particles can also pose a hazard when inhaled or ingested. These forms of exposure are rarely considered in risk assessments or in determining acceptable levels of pollutant emissions.

Danger from Dust

The high concentrations of heavy metals in the soils and house dusts near smelters show how health risks can be underestimated. Clean Air Act regulations address lead only in the ambient air. But in these communities, residents' elevated blood-lead levels have been linked to concentrations of lead in the soil. These increased concentrations are the result of ambient

ILLUSTRATION: KEVIN C. HAWKES

air standards too high to account for deposition and accumulation. Elevated blood-lead levels in children can cause developmental problems, while chronic lead poisoning in adults can damage the peripheral nervous system and increase the risk of heart disease.

People inhale and ingest soil in several ways. Every breath takes in numerous suspended dust particles. Chewing on a pen or eating, for example, brings hands to the mouth, transporting dust to the digestive tract. Children, who often eat dirt, are more sensitive than adults to many toxins. Amounts of soil ingested by children vary, but recent estimates suggest that even through normal activities such as playing with toys children generally eat between 0.1 and 10 grams of soil daily.

Soil contaminants can also be ingested through food. Some root vegetables may accumulate dioxins, heavy metals, and PCBs from the soil, while leafy vegetables may incorporate contaminants from dust. Grazing animals ingest dust and dirt, and shellfish and bottom-feeding fish concentrate pollutants from sediments when they feed. The toxins can then be transferred to humans. For example, pesticides and heavy metals that are deposited on the sediments of the Great Lakes become concentrated as they are passed along the food chain. Regional authorities therefore recommend that the consumption of salmon and other kinds of sport fish be limited or avoided.

Through ingestion or inhalation, soil contaminants can enter the body directly and move through the bloodstream to the liver and other organs that accumulate toxins. In pregnant women, the rapidly developing cells of the fetus are especially vulnerable to toxins, increasing the possibility of birth defects or developmental problems.

Pollution From Ill Winds

Environmental laws also neglect the fact that contaminated soils and sediments can travel long distances suspended in air or water. Consider how pesticides adhering to soil particles can be blown into the air, traveling great distances before returning to earth dissolved in rain. Potentially toxic pesticides used primarily in the South have turned up in the Great Lakes region, in concentrations that are too high to have come from local farms.

A radical rethinking of how we protect our environment is required. Soils and sediments must be brought into the picture. Consequently, air and water pollution must be lowered to compensate for the soil's ability to accumulate and disperse all kinds of contaminants. Also, reductions of emissions are essential for chemicals such as metals and persistent pesticides that are not readily degraded in the environment.

In addition to emission controls, the prevailing approach to both industrial waste and household garbage must be changed from "Where will we put it?" to "How can we minimize it?" While soils have always been the ultimate dumping ground, a recognition of the environmental harm this is causing may convince our throwaway society that there is no "away."

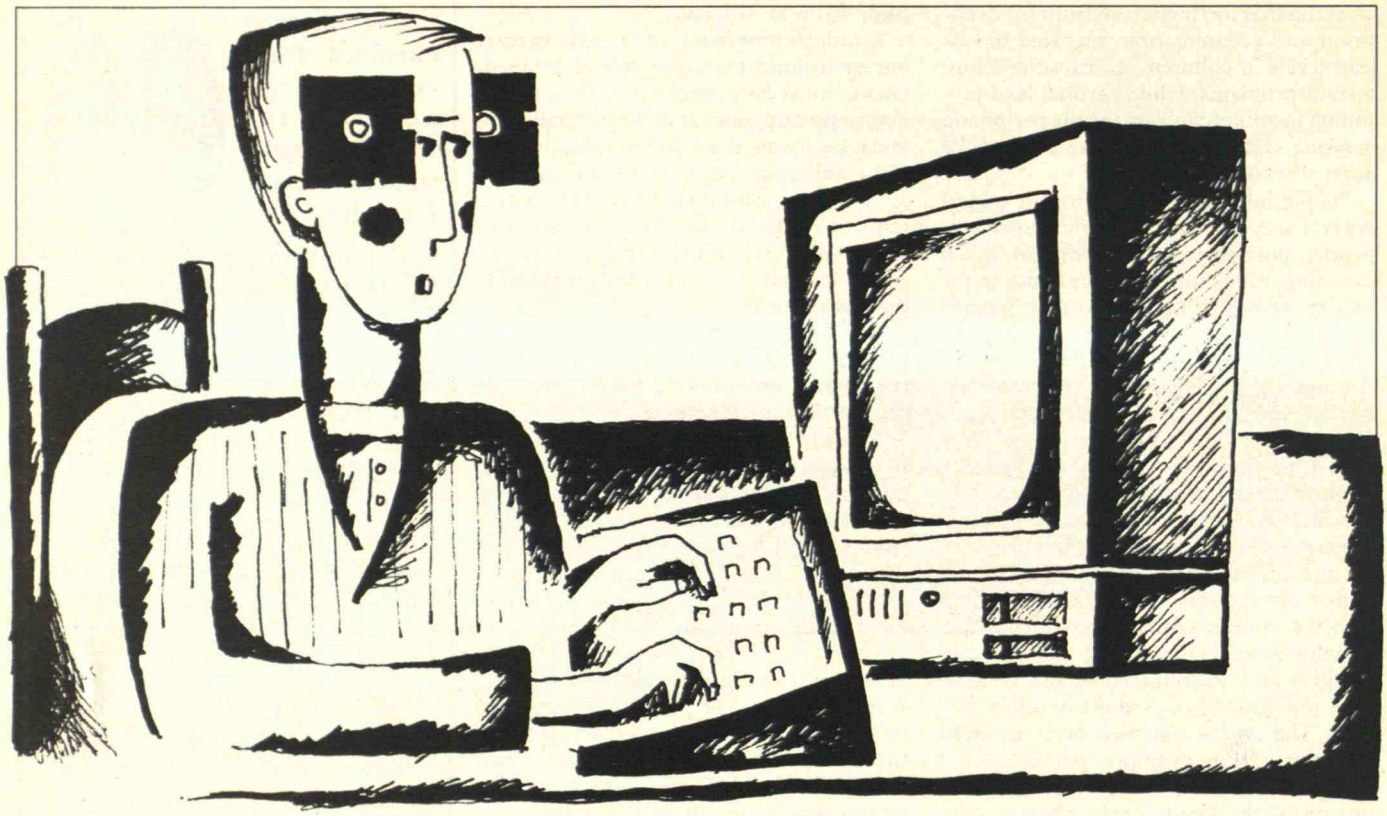
Revamping Statutes Is Not Enough

Such major changes do not happen easily. A law on the order of the Clean Air Act or Clean Water Act is necessary, since all the laws pertaining to air and water pollution, toxic substances, and hazardous wastes would be affected. The necessary changes could not be brought about—certainly not consistently—in the course of reauthorizing existing environmental statutes. But a clean soil act could adopt the regulatory structure created by our existing environmental laws and incorporate a coordinated effort to protect our nation's soil.

Such a statute would explicitly recognize the hazards that contaminated soils and sediments pose to human health and the environment. The use of soils and sediments for waste disposal would have to be restricted. Regulations concerning emissions into air and water would have to deal with soil deposition and accumulation. In addition, remediation projects directed at contaminated soils and sediments that are outside the scope of existing programs like Superfund are needed. Such projects could range from schoolyards with lead-contaminated soils to wildlife habitats contaminated by agricultural runoff. Since the scope of these projects demands deliberation, we can at least begin now to change our attitude toward soils and sediments. □

BY BRUCE R. HERRICK

Curbing Abuses in Computer Modeling



BUREAUCRATS today are adding another tool to their paper and pencils—computer models. Modeling complicated problems on computers is often better than trying to solve them by judgment alone, but models can present subtle pitfalls. They may camouflage biases in a myriad of numbers. The more complex the model, the greater the potential for such problems. The public should be skeptical of unnecessarily large models and government agencies should avoid their use. By contrast, the best models are easily understood by those who use them and those who are affected by their results.

Consider two cases. The Wisconsin Department of Natural Resources has successfully used a model to develop permits for paper companies that dump organic wastes into the Fox River in northeast Wisconsin. On the other hand, a model used by the U.S. Forest Service since 1979 to prepare detailed management plans for the country's 123 national forests has faced strong criticism.

The public is rightfully dissatisfied when social policy depends on overly complex computer models.

The plans are supposed to ensure that all the functions of the forests—from wilderness and watershed protection to recreational uses and timber production—are sustained. By last summer, affected parties had filed 376 appeals with the Forest Service concerning the 66 final plans. Many conservation groups alleged that the model—known as FORPLAN (as in "forest plan")—is being used to increase logging and unnecessary roadbuilding, thereby reducing wilderness.

The Wrong Choice

FORPLAN favors timber harvesting because it grew out of a simpler model that scheduled the growing and cutting of timber. Instead of evaluating different models, the Forest Service broadened the scope of its timber-scheduling model to develop multiple-use plans. "By default [the National Forest Service] chose economic efficiency over the detailed simulation of environmental effects," says FORPLAN's primary developer, K. Norman Johnson of Oregon State University's Department of Forest Management.

In addition, FORPLAN is the wrong choice for a multiple-use management model because it represents the world in

BRUCE R. HERRICK, a doctoral student in land resources at the University of Wisconsin, is studying the application of models to environmental problems.

ILLUSTRATION: SOPHIE SCHILLER

terms of linear equations. For example, FORPLAN assumes that the millionth acre of clearcut forest will increase the deer population by the same amount as the first acre. But while clearcutting stimulates new plant growth that deer eat, it gradually reduces their shelter. Moreover, FORPLAN calculates that another mile of road will bring in the same amount of recreational benefits as the first, no matter how much road is already built. In fact, as the number of people approaches the entire population of nature lovers in an area, each successive mile will attract fewer visitors.

Worse than these weaknesses are the biases introduced by the Forest Service's operation of FORPLAN. Randall O'Toole, who heads the environmental group Forest Watch in Eugene, Oreg., has examined more than 40 final management plans. He has found that all of them contain operational errors that favor harvesting. For example, although timber prices have fallen from their peak in 1979, prices from the late 1970s are often used as the current and future prices. In many cases, the Forest Service will have to spend more to build roads to lumbering sites than it will actually receive for the timber, according to O'Toole.

Hidden Agenda

The Forest Service appears to have a hidden agenda. The agency seems interested in building roads to keep as much land as possible available for the timber industry. Moreover, the agency increases discretionary funding by applying receipts from the sale of timber rights to programs such as reforestation, O'Toole notes.

The agency foils many critics through FORPLAN's size and complexity. The computer solves thousands of interdependent equations with thousands of variables at once. The result may look scientific, but agency judgments are reflected in the subjective values assigned to those variables and the equations' coefficients. For example, the Forest Service often assigns less value to a "hiker-user day" than to a "hunter-user day." This is a highly subjective opinion that favors road-building, since hunters use roads more intensively than hikers do.

The model's complexity has thwarted public involvement in checking the model, although citizen participation in forest planning is required by the 1976 National Forest Management Act. Oregon State's Johnson charges that "the Forest Service holds FORPLAN between itself and its critics as superstitious people in the Middle Ages held icons between themselves and the devil." No wonder legal challenges abound.

A Model That Can Be Understood

Now compare the widespread public dissatisfaction with FORPLAN to the success of the model used by the Wisconsin Department of Natural Resources for managing organic waste in the Fox River. Decaying organic matter in the water depletes dissolved oxygen, without which fish die. To simulate conditions under which the dissolved oxygen falls to a dangerous level, the model uses variables for only a few factors, including water velocity and temperature and the amount of organic waste.

The department worked with industry and citizens in the model's development, an approach that led to a relatively high acceptance level. Furthermore, when the paper industry pointed out discrepancies between the model's estimates and actual water measurements, the model was revised and its performance improved. The resulting regulations and discharge permits were flexible yet satisfactory to both industry and conservation groups.

Of course, the Fox River model has a much narrower focus than FORPLAN. But regulators could replace a cumbersome model such as FORPLAN with a set of smaller models, each of which would deal with a different aspect of a plan. Questions involving more than one aspect could be resolved by transferring information from one model to another.

How might this work with FORPLAN? Results from a model of the population dynamics of endangered species could be plugged into a model that schedules lumbering. Species that need clearings might benefit from more harvesting, while those that require a deep-woods habitat would fare better with less.

Smaller models are easier to understand and their subjective assumptions are more apparent. And all the interested parties can effectively critique the modeling techniques. The public should demand the use of these models. □

Sputnik's Heirs:

What the Soviets Are Doing in Space

BY PETER PESAVENTO

As the world marks the 30th anniversary of Sputnik, the Soviets are making ambitious plans to colonize space and continue unmanned exploration.

On April 11, 1987, in Moscow, the time was a quarter to midnight. In orbit, veteran cosmonaut Yuri Romanenko and rookie Alexander Laveikin were about to start an unrehearsed spacewalk. The objective: to troubleshoot a multi-hundred-million-dollar astrophysics module that had failed to dock with the *Mir* ("Peace") space station. The cosmonauts were working against time: the batteries used to maneuver the *Kvant* ("Quantum") module—which contained a contingent of x-ray and ultraviolet telescopes from Switzerland, Great Britain, West Germany, and the European Space Agency—were about to run down. If that happened the module would never dock—a potentially catastrophic setback for the Soviet manned program.

Opening hatches in *Mir*'s front section, the cosmonauts began their slow climb to the aft end of the station. The two carried a satchel of tools and flashlights, for the first part of the walk was occurring in Earth's shadow. The urgency of the mission was underscored by the fact that the men did not carry a video camera to record their work—they did not have time to seal one against the interstellar vacuum.

Ten minutes into the walk, a minor crisis: "The pressure in my suit is falling!" Laveikin said excitedly. In the tense moments that followed, Romanenko spotted the problem—a maladjusted pressure control on the front of his partner's suit. The veteran's gloved hand corrected the switch, and the slow crawl continued. Several minutes later, they arrived at *Mir*'s back port where the *Quantum* had been attempting to dock.

Gingerly, the cosmonauts examined the area between the two 20-ton craft. The flashlight beams were unusually bright in the darkness: 300 kilometers below, the two could see the bluish blackness of the southern Atlantic.

"We can see something, some white object," reported Laveikin.

"Can you get in there without taking any risk?" inquired flight control in Moscow.

"If you pull the vehicles still wider apart, we'll try to get it out," replied Laveikin. Flight control said it could, and soon, via radio command, the two craft moved several dozen centimeters apart. During this process, the darkness gave way to an oranging dawn and then instant—almost blinding—brightness. The two cosmonauts flipped down their sun visors.

The men could see that the previous docking attempt had jammed an unknown object tightly into *Mir*'s apparatus. To free it, the two worked in relays. Flight control attempted to break the mostly silent effort by querying the pair. "Is it round, flat, or square?" Rebuffed by minutes of silence, the controller tried again, with humor: "Any UFOs there?" This too failed to draw a response. Beneath the cosmonauts, the multiple hues of Europe wheeled by.

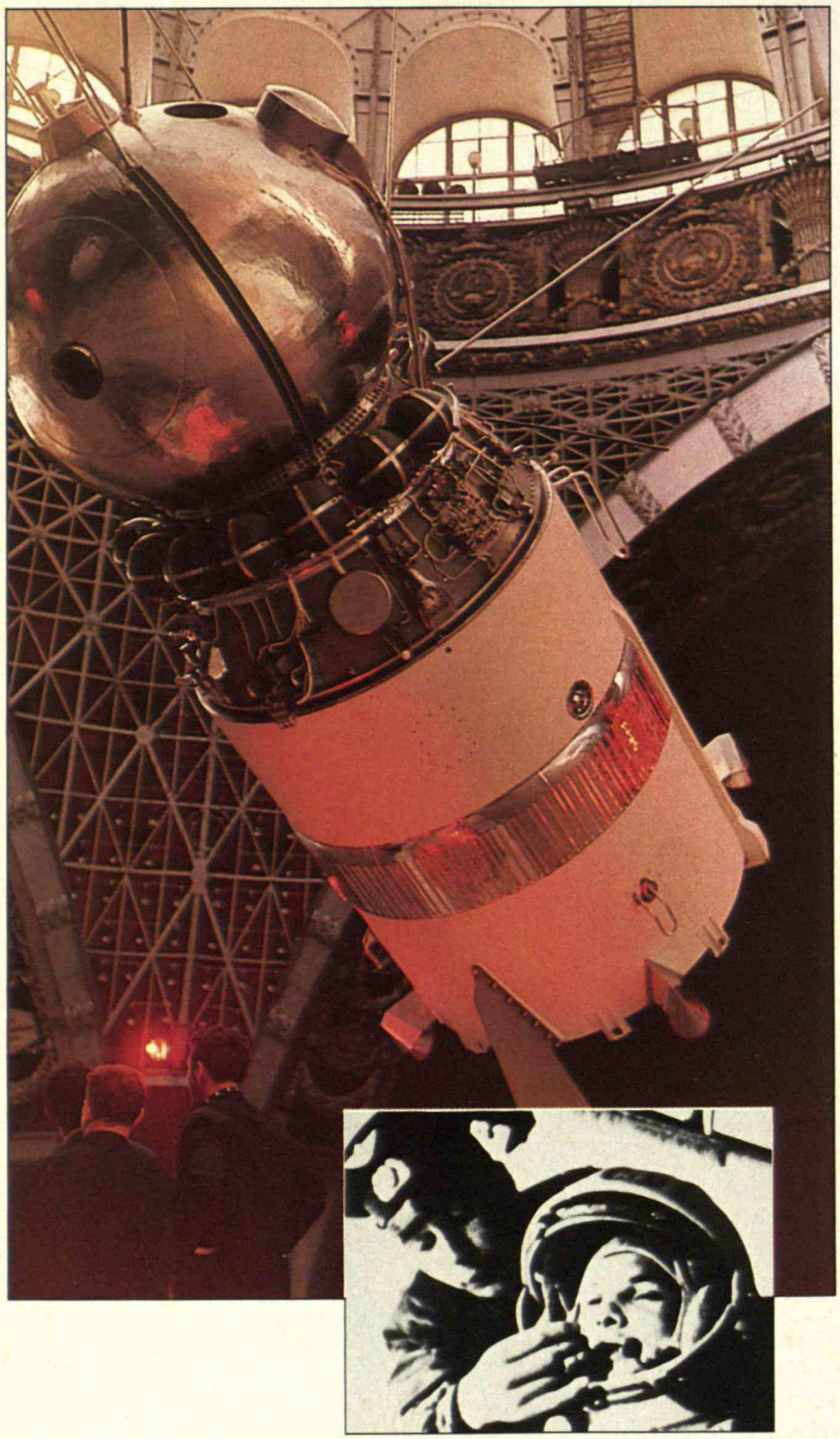
Finally the object was removed: a 40-centimeter-square bag of trash. Somehow the sack hadn't made it into a previously docked transport craft that was used as a garbage truck. As the cosmonauts flung it away, the tension both in orbit and in Moscow evaporated. The long-awaited firm docking was achieved two minutes later.

For the third time in four years, cosmonaut hands had averted the Soviet space program from disaster.

PETER PESAVENTO is a free-lance writer specializing in space. His articles have appeared in Astronomy, New Scientist, Griffith Observer, *and* Space World.

ILLUSTRATION: SUSAN LE VAN

An exact replica of the world's first manned spacecraft, *Vostok 1*, piloted by Yuri Gagarin. The cosmonaut flew the craft for 108 minutes in 1961. Inset: Gagarin is fed a "good-luck" caramel by Grigori Nelyubov. According to news reports released as part of Gorbachev's *glasnost*, Nelyubov committed suicide after being removed from the cosmonaut team for "egocentrism."



In 1983, ruptured fuel lines on a *Salyut* space station had required a program-saving spacewalk to repair the problem. In 1985, two cosmonauts brought a frozen and near-derelict *Salyut 7* back to life by removing, thawing, and repairing the station's electrical and heating equipment.

Such dramatic efforts attracted little attention from the Western media. The USSR has long labored out of the global public eye while the world has focused on the spectacular successes of the American space program. Yet the eclipsing shadow over the Soviets vanished on that cold January morning when *Challenger* disintegrated in the Florida sky. The maturing Soviet space technology has come into bold relief, emphasized by an unprecedented torrent of information about the USSR's efforts past, present, and future released as part of Premier Gorbachev's *glasnost*.

This year will be remembered as a milestone in the Soviet space effort, and not only because it is the thirtieth anniversary of *Sputnik I*, the first spaceflight. As demonstrated by the recent launch of their superbooster *Energia*, the Soviets have embarked on an ambitious and accelerating program of space activity. Unmanned missions scheduled for the late 1980s and 1990s are impressive: probes to asteroids, Venus, the martian moons, and the surface of Mars itself. The Soviets' series of manned space stations is nearing the end of its experimental stage, and permanently inhabited facilities will soon be in place. The Russians are also making plans to colonize Mars, and efforts to manufacture materials in space are under way.

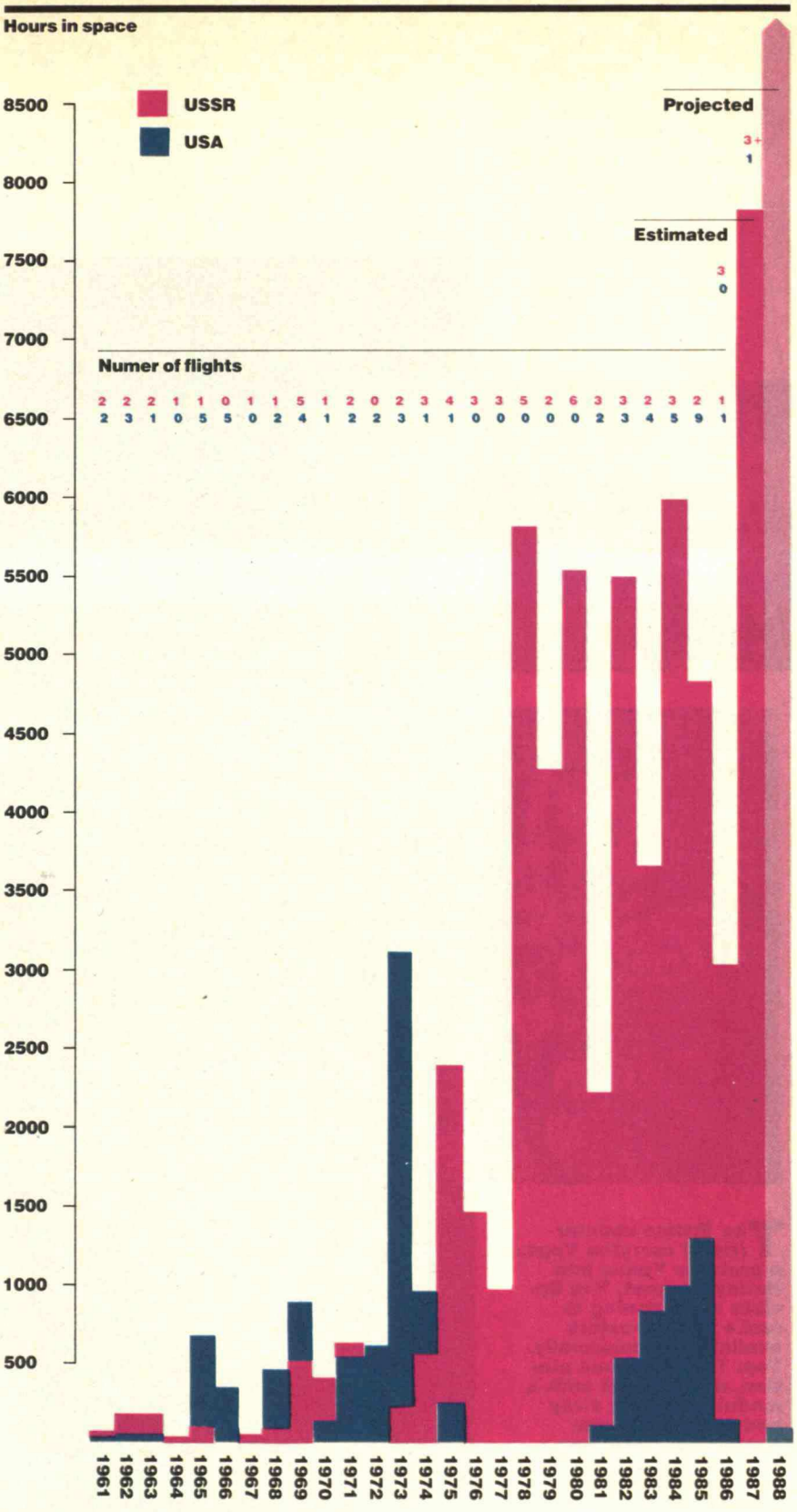
PHOTOS: NOVOSTI PRESS AGENCY

*Glasnost*ing Space

Since the launch of the first *Sputnik* in 1957, Western analysts have noted glaring omissions in the USSR's statements about its activities in space. However, after Premier Brezhnev's death in November 1982, the Soviets began to reveal a wide range of details about their program, albeit piecemeal. During the Andropov/Chernenko tenures, officials admitted the existence of rocket bases at Plesetsk and Kapustin Yar. They also acknowledged failed docking attempts and an aborted *Soyuz-T* launch in which cosmonauts were ejected just seconds before the booster exploded on the pad.

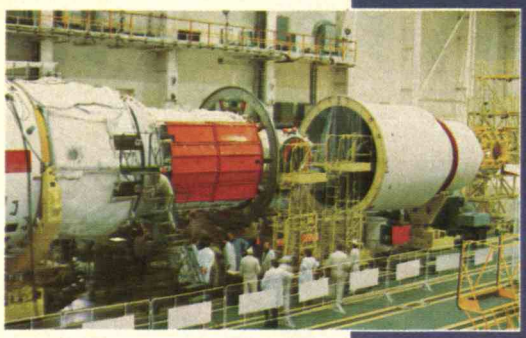
Five months after the *Soyuz-T* "anomaly," Mikhail Gorbachev ascended to the top position in the Soviet government. The effects of his *glasnost* policy have been amazing. One of the first indications of its influence was live television coverage of the December 1984 launching of *Vega*—a probe to Venus and Halley's comet—which featured the Proton booster. The Proton, then the USSR's most powerful satellite carrier, had never before been shown publicly despite the fact that its first orbital flight occurred in 1966.

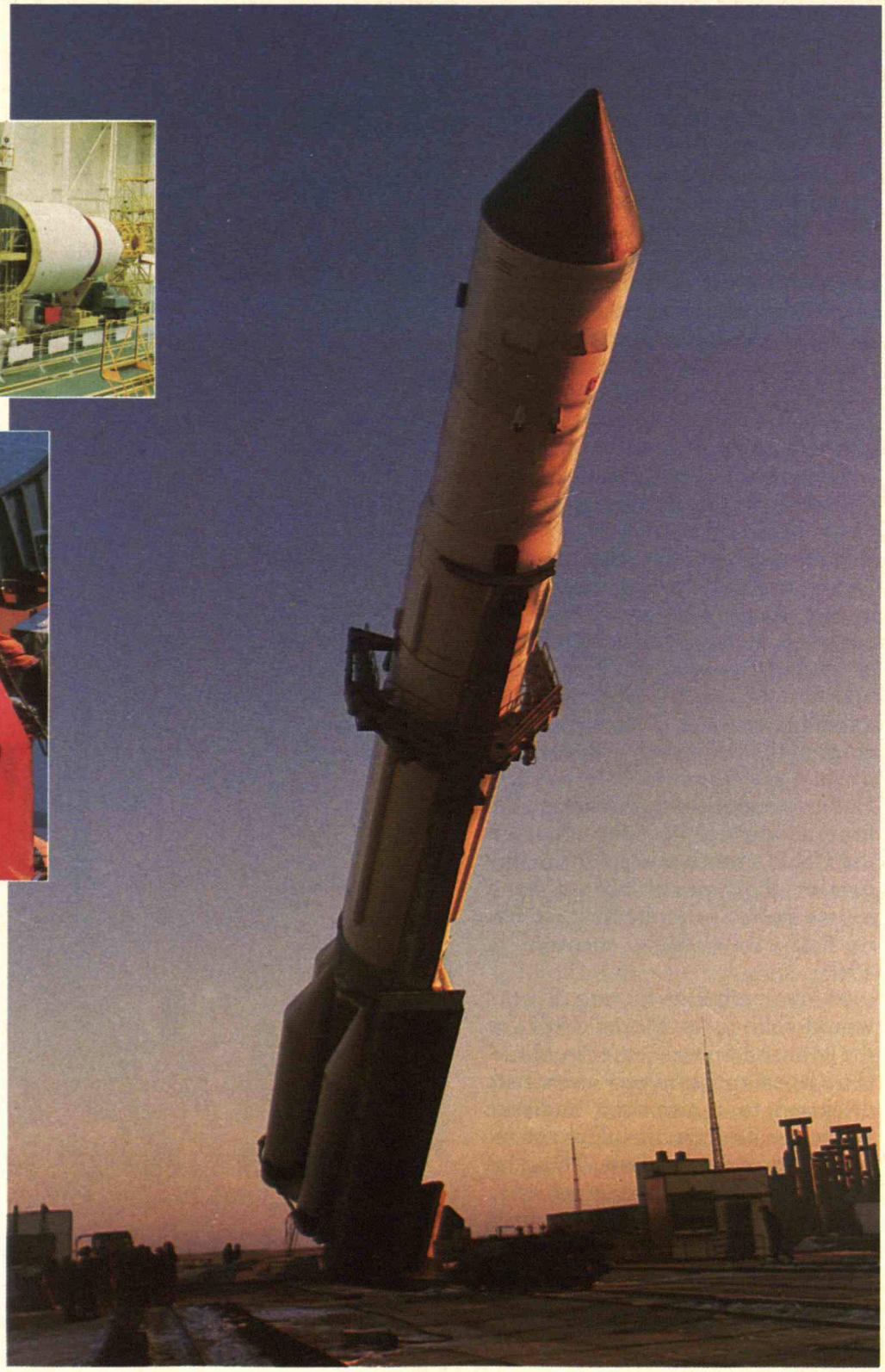
More eyebrow-raising events would follow. In March 1985, at the Johnson Space Center in Houston, Russian planetary scientists disclosed to a surprised audience ambitious and specific plans for interplanetary exploration. These included a 1988 launching of a mission to Mars involving landings on Phobos, a martian moon; a 1990 launch of a lunar polar orbiter to map the geography and chemical



The Soviets' total time in space recently reached 13 years. The corresponding figure for American astronauts is 4 years, 10 months. The Soviets plan to use their extensive experience to operate space stations in the coming decade. The proposed American station will not be built until the mid-1990s, at the earliest.

CHART: TOM BRIGGS DESIGN





The *Proton* booster (right) carrying *Vega*, a probe to Venus and Halley's comet. The Soviets are planning to make their boosters available commercially. Top: The *Mir* space station, now in orbit with a module carrying x-ray and ultraviolet telescopes from Western Europe. The station has ports for five other science modules. Above: Crew members of the *Soyuz TM-2*, one of the vehicles used to ferry cosmonauts and small experiments between *Mir* and Earth, training for splashdown.

Rumors of intoxication had long haunted the death of Uri Gagarin in a jet crash in 1968.

composition of the Moon's surface; and a landing on Venus and an asteroid proposed for 1994.

In 1986, the Soviets provided several unprecedented glimpses of their efforts in manned spaceflight. In February, they showed the launch of a new orbital station live on television. In March a space mission was announced several days in advance—rather than after the crew was in orbit. That launch was also broadcast live. The results must have been encouraging, for five months after the crew's June return, an atypical press conference was held. This Christmas-week event announced the crews for a joint Soviet/Syrian mission to *Mir*, part of the Intercosmos series in which cosmonauts from Eastern Europe as well as Mongolia, Vietnam, Cuba, France, and India have visited Soviet space stations.

Perhaps the most revealing disclosures have been newspaper stories about the first cosmonaut cadre chosen in 1960, and the first human to orbit the Earth, Yuri Gagarin. A series in *Izvestia* commemorating the twenty-fifth anniversary of Gagarin's flight revealed Valentin Bondarenko as the first known space-related casualty. During an isolation-chamber test, Bodarenko carelessly threw a swab soaked in alcohol, used to attach body electrodes, onto a heating coil. In the pure oxygen atmosphere a conflagration ensued. Rescue teams managed to get into the chamber while Bondarenko was still alive, but he died eight hours later from burn shock.

An untimely end befell another member of the cadre, Grigori Nelyubov, who was the second stand-in for Gagarin during preparations for the first manned flight. *Izvestia* revealed that because of Nelyubov's "egocentrism" and "nearly complete absence of self-criticism," he was removed from the space program. He was later arrested during a skirmish with a military patrol and sent to a remote Far East air base, where he experienced "a serious spiritual crisis" and was "killed in a state of intoxication by a passing train." Many Westerners interpret this sad tale as the first space-related suicide.

Rumors of intoxication had long haunted the untimely death of Yuri Gagarin, who was killed in a jet crash in 1968. Nineteen years afterward, an article in *Pravda* dispelled the notion that Gagarin was drunk on his final flight, citing a previously secret analysis of his remains. The newspaper account conceded that pilot error was a factor in the crash, as was a freak atmospheric phenomenon akin to wind shear.

The most impressive example of *glasnost* has been the information released concerning the recent launch of the Soviets' new heavy-lift super rocket *Energia*. With a height of 60 meters, a weight of 2,000 metric tons, and a thrust of 4,000 metric tons, *Energia* is the world's tallest, heaviest, and most powerful launcher. The fuels for the second stage, liquid oxygen and liquid hydrogen, mark the first Soviet use of this combination of super-cold elements. *Energia*'s launch was announced a day in advance, with the preparations and firing shown on live TV. When the payload, a heavy mockup satellite, failed to achieve orbit, this too was reported.

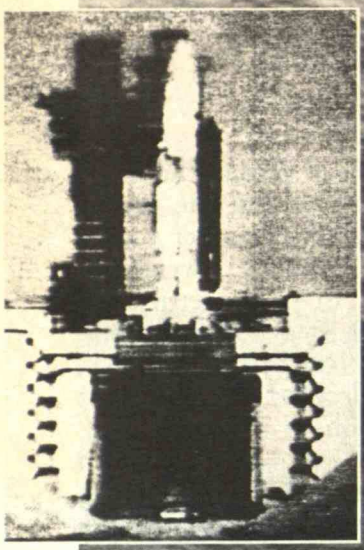
According to British space expert Rex Hall, the mission was still successful. "The main objective of the maiden flight was to see it if would fire its engines, leave the pad, and follow the planned trajectory correctly. It did so. Whether the mockup went into orbit was of much lesser importance. I think it is significant that soon afterward the problem with the payload was reported and diagnosed."

While Soviet officials talked on Radio Moscow about *Energia*'s ability to hoist future space shuttles and "100-ton blocks of components for future large orbital complexes," as well as to send probes to the Moon, Venus, Mars, and Jupiter, the *Mir* space station has been silently moving at 18,000 miles per hour toward the USSR's imminent future in Earth orbit.

Nascent Orbital Village

"It's like a huge seagull!" marveled *Soyuz T-15* crew members as they viewed *Mir* from orbit in March 1986. The space station was then only two weeks old. Now, less than two years later, this eighth edition of the Soviets' series of manned stations is on the verge of spreading its wings on "a new chapter in the history of spaceflight," according to Viktor Blagov, deputy director of the space station program.

Like the seven *Salyut*s, *Mir* includes a transfer module (which cosmonauts use to shuttle between the station proper and the *Soyuz-TM* craft), a module for working and living, and an engine/instrument module. The station also has two new features: three solar panels 10 meters long (one of which was assembled in space) that generate 8 kilowatts of electrical power, and a module on the fore of the craft that has five ports for science modules. A sixth port now hosts the *Kvant* astrophysics module.



The Soviets retrieve *Cosmos 1445*, probably part of a program to develop a shuttle. The resulting vehicle, expected to be similar to the U.S. shuttle, may fly within the next year. The Soviets plan to announce all launches in advance. Inset: *Energia*, the world's most powerful rocket, shown on TV before its launch this year. The rocket will boost the shuttle into orbit.

Inside, *Mir* is vastly different from any of the *Salyuts*. In contrast to the previous instrument clutter, the new station is remarkably spacious. The Soviets anticipate that almost all experiments will be done in the docked modules, leaving the living section to the cosmonauts. The walls of the living area are painted yellow, "which is conducive to relaxation," according to *Izvestia*, and the floor is covered with carpet. Computers now control most of the station's systems, including circulation, temperature, and position; cosmonauts previously had to spend much of their time checking these functions. The largest number of people that could squeeze into the *Salyuts* was 5, with only 2 or 3 cosmonauts housed during usual operations. In *Mir*, the number of crew members for long-duration missions is expected to be 5, with the station accommodating 10 to 12 for short periods.

Some Western analysts maintain that the Soviet manned space program is strictly political window dressing, with the cosmonauts forced to work with unsophisticated equipment and faced with weeks of monotony. "That's an invalid viewpoint," asserts Nicholas Johnson, author of the annual *Soviet Space Year*. "The Soviet manned program is not a 'Potemkin Village' affair."

The facts bear Johnson out. Nearly 3,000 basic and applied experiments have been conducted aboard the Soviet stations. There is a clear trend toward space manufacturing and materials processing: a total of more than 600 such experiments were conducted on *Salyuts* 6 and 7, in contrast to the 20 or so done aboard *Salyuts* 4 and 5. The Soviets predict that they will obtain pieces of semiconductor material weighing as much as 35 kilograms by 1995.

In contrast, Americans conducted only 16 materials-processing experiments aboard the three Skylabs during 30 hours of flight time. Today, since flights of the U.S. shuttle last only a week, some

The most anticipated manned mission since the Moon landing is the maiden flight of the Soviet shuttle.

procedures are impossible. For example, Alexander Laveikin recently used a semiconductor furnace to conduct one test lasting more than 100 hours. Such an experiment could not be done aboard the shuttle.

Recent events show that the Russians' confidence in their equipment is high. At the Paris Air Show in June, the Soviet delegation released a "Consumer's Guide" to the *Mir* station and its equipment, hoping to convince customers to buy space and time for onboard experiments. The guide included unprecedented details on the equipment, which includes a crystallization facility for manufacturing materials from both liquid and gaseous states, and an electrophoresis unit for creating biological and pharmaceutical substances.

"The stereotype of crude Soviet technology is being shown to be more and more inaccurate," says Rex Hall, a fellow of the British Planetary Society. "At times, they do prefer to use simpler equipment than the Americans, yet it works very well. They would not have offered their instrumentation on the world marketplace if it was not up to par."

Some Western observers expected that the *Kvant* astrophysics module now docked with *Mir* would not be effective because of vibrations from the joined vehicles. Yet as Hall points out, European scientists would not have contributed the x-ray and ultraviolet telescopes on board if they thought they would be of no use. Indeed, the Soviets discovered after the *Kvant* module began operating in July that its telescopes had a resolution of one arc-minute—10 times better than the Russians initially promised their European partners during negotiations in 1980. As a result, requests for observing time have increased, with 37 in July alone.

Cosmonauts reportedly spend 85 percent of their waking hours monitoring experiments, updating computer programs, and maintaining the station. However, loneliness can still be a problem. The *Soyuz T-14* crew had to cut short its stay on *Salyut 7* in 1985 because the commander, Vladimir Vasyutin, apparently had a severe case of depression. Because of his incapacitation, he was no longer the commander when the spaceship returned to Earth.

Manned activity aboard *Mir* seems to be accelerating. According to spacecraft designer Valentin Semyonov, the Soviets expect to send four modules to the station in the next five years. A remote-sensing laboratory is scheduled for launch before the end of November, and the Siberian branch of the USSR Academy of Sciences is building a greenhouse for growing food plants and regenerating oxygen. From 1972 to 1985, such a greenhouse tested in the city of Krasnoyarsk was found to work with "95 percent autonomy."

Also in November, French sources say, a new crew will swap places with current crew members for a one-year stay. Next spring, a joint Soviet/Bulgarian team plans to visit *Mir* for a week. In November of 1988, a French/Soviet crew will arrive for a month-long visit. And Austria recently signed an agreement that will allow an Austrian astronaut to visit *Mir* in the early 1990s. An all-woman crew is also expected to board the station in the near future.

The flying record of cosmonauts aboard Soviet spaceships recently reached a total of 13 years. The corresponding figure for astronauts aboard U.S. craft is 4 years and 10 months. While the U.S. space effort attempts to get back on track after *Challenger,* and plans for building a space station fade into the late 1990s, academician Boris Paton's remarks on Soviet aspirations reveal a marked contrast: "Orbital complexes of the next decade are likely to have a mass in excess of 150 tons and measure hundreds of meters. Their service life will be 15 to 20 years."

The Soviet Space Shuttle

Perhaps the most anticipated manned mission since *Apollo 11* is the maiden flight of the Soviet space shuttle. Western experts have been watching for signs of its development since 1969, when they first learned that models were being tested in wind tunnels at Novosibirsk.

Information about the shuttle during the 1970s was spotty. Western analysts identified three launches toward the end of the decade as shuttle reentry tests. The early 1980s were more auspicious. On June 3, 1982, *Cosmos 1374* descended by parachute into the Indian Ocean while Australian and American vessels looked on. Journalists were allowed to interview cosmonaut Alexsei Leonov the following week, but he declined to answer pointed questions about the obscure flight. In 1983, after the splashdown of *Cosmos 1445,* the U.S. Department of Defense announced that the Soviets were pursuing a two-pronged program that included a *Columbia*-sized shuttle and a smaller space plane.

Not until April 1987 did the USSR officially admit to a shuttle program, with Stefan Bogadyazh, head

Soviet rovers and balloons are expected to roam the surface of Mars by the early 1990s.

of the project, revealing that all launches would be announced in advance. Soon after, Gorbachev toured the Baikonur Cosmodrome (the first visit by a Soviet premier in almost 20 years) and the launch pad of one of the shuttle's main components—the *Energia* heavy-lift booster.

The Soviet vehicle will be used in much the same way as the U.S. shuttle, transporting satellites into orbit, repairing them, and taking equipment and personnel to and from *Mir* and future space stations. It will also look remarkably like the American vehicles but may have more flexibility when landing. According to *Aviation Week,* a set of air-breathing jet engines installed near the tail will allow cosmonauts to align the craft with the runway or to fly to another airstrip. This is in contrast to the pure glider of the U.S. shuttle, which must land on the first pass. However, unlike the Americans, the Soviets do not have shuttle landing sites around the world. And since Baikonur experiences temperature extremes, the vehicle can be launched during only two-thirds of the year.

The U.S. craft has a thrust at lift-off of 7.4 million pounds and a lift-off weight of 4.8 million pounds. In contrast, *Energia*'s lift-off thrust is 8.8 million pounds, and the Soviet shuttle has a lift-off weight of about 4.6 million pounds. Thus, with the extra thrust provided by *Energia,* the Soviet shuttle may be able to put 41 metric tons into orbit compared with the U.S. shuttle's 34. Yet there are hints that—unlike the Americans—the Soviets will not choose the shuttle as their only launch vehicle. According to Radio Moscow science correspondent Boris Belitsky, "The notion by Americans that the use of a shuttle craft is more economical than other means is not quite so. [We plan] to use it in parallel with other craft in our stable of vehicles." Space experts think that the Soviet shuttle could fly within the next 12 months.

In contrast, evidence that the Russians are developing a smaller space plane to be used just for ferrying cosmonauts is unclear. According to Marcia Smith of the Library of Congress: "I'm not quite sure in a strained economy—and theirs is more strained than ours—why they would feel a need to introduce two new manned spaceships." But others disagree. According to Nicholas Johnson, author of *Soviet Space Year,* "The economic argument is tenuous at best. We have a long history in the West of saying what the Soviet economy can or cannot do. As in our own economy, if a program has priority, then funding will be made available." Jurgen Esders, a West German member of the European Parliament, thinks that the Soviets will launch a space plane this year.

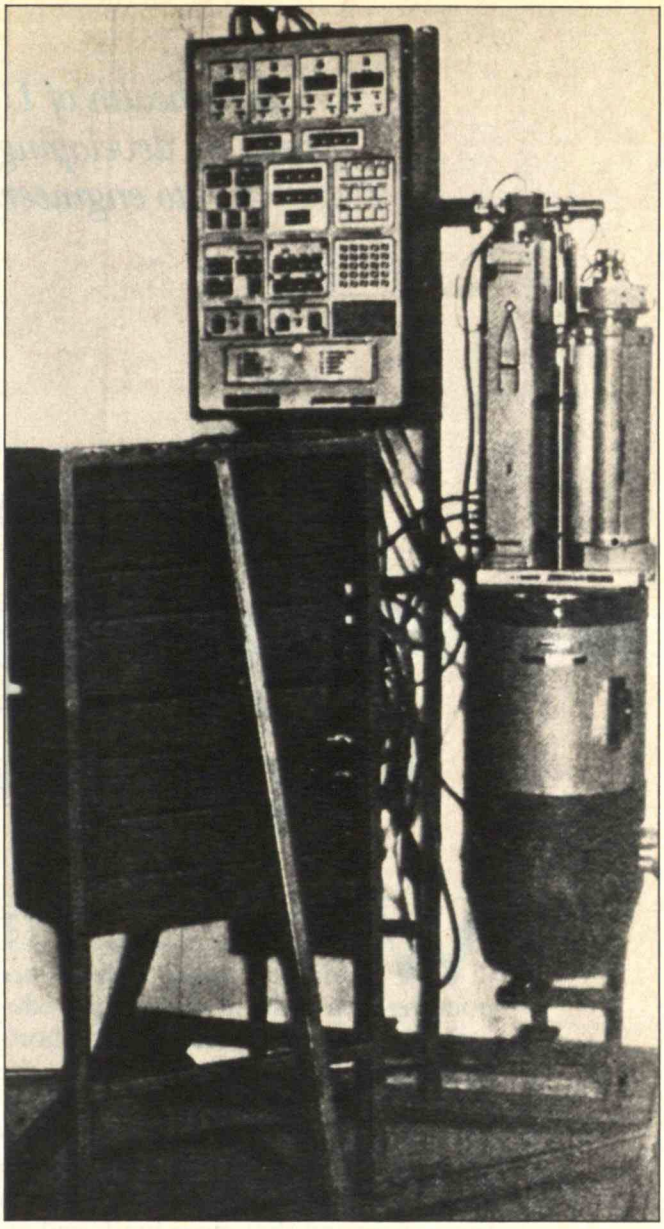
According to American analyst Charles Vick, an expert on Soviet rocketry, the Soviet space plane is a "mini-shuttle designed so that many can be built fairly cheaply. The Russians could have a whole assembly building full of these craft for use between turnaround times of the large *Columbia*-class spaceship." For, as NASA officials have found, the shuttle's recycling time is about 14 weeks—unsatisfactory for a vigorous manned program.

A Canticle for Tsiolkovsky

"To set foot on the soil of asteroids; pick up a Moonstone with one's hand; build stations moving through the ether; form living rings around the Earth, Moon and Sun; look upon Mars from a distance of a few dozen versats, land upon its satellites, or even on the surface of the planet itself—all this may well seem extravagant. . ."—from Konstantin Tsiolkovsky's diaries, 1911

Thirty years after *Sputnik* vacated its launching pad and flew into history, the memory of "the father of Soviet cosmonautics" is still strong, and the Russians are nearing the time when even his "extravagant" ideas will be realized. Tsiolkovsky's dream of populating the space between the Earth and the Sun is apparently being taken seriously. Academician Boris Paton comments in a paper published in December 1986 that "today, major permanent orbital stations to be manned by thousands are on the drawing boards." Nor has Soviet interest in the Moon waned, despite the loss of the race to that satellite. Rather, says scientist Tamara Breus of the Moscow Space Research Institute, "The Moon will be the first extraterrestrial base of Earthlings." The Russians also expect to build solar power stations hundreds of kilometers in area to beam electricity to Earth, and they envision establishing space factories with dozens of cosmonauts.

Looking beyond Earth orbit, the Soviets are focusing forcefully on Mars. Cosmonaut Viktor Savinkyh told a Yugoslavian audience in 1986 that he had already signed up for a flight to Mars, and that it would involve *Mir* by 1995 and probably be cir-



A processor and furnace used to test semiconductor materials aboard *Mir*. The Soviets have conducted more than 600 manufacturing experiments in space. A guide gives Western customers details on equipment aboard *Mir*.

cumplanetary. Soviet participants at a recent conference in Pasadena outlined specific missions to that planet. After Project Phobos in 1992, a roving vehicle will roam over the Martian surface for miles. Balloons will drift over vast parts of the surface, landing in the cool of the night to collect samples. In 1994 or 1996, a Soviet spacecraft will carry a long-range rover to the Mars surface, possibly traversing up to 500 kilometers of the planet. A follow-up mission would be the first attempt to bring back Martian samples (using the space station as a base). No American effort matches the breadth and scope of this plan.

On Earth, the USSR is actively promoting a wide range of space assets for commercial use. Aleksander Dunayev, head of the *Glavkosmos* agency (the counterpart of NASA), stated that the *Energia* booster would be supplied to foreign partners, as would other booster rockets. He went on to say that "providing separate communication channels on our geostationary satellites, sending satellites into points suitable for the customer . . . are also possible."

The United States will not have a counterpart to *Energia* until 1993 at the earliest—the result of abandoning Saturn Vs when the glory and excitement of the Apollo era began to fade, and of lacking any other long-range commitment to manned spaceflight. The United States has not had a manned orbiting station in 13 years, and the 12-person structure now being proposed may not be realized for another 10. If the space station is viable in 1996, the Americans will have to build painfully on the meager 84-day experience of the *Skylab 4* crew. In contrast, the Russians will have a decade of experience with living in space for a year at a time. Moreover, the Soviets have averaged 100 launches per year for 16 years. The United States has not orbited 50 missions since 1971, and only 3 attained orbit in 1986.

Why is the Soviet Union so interested in spaceflight? A casual examination of that nation's attitude toward the subject reveals much. Rarely a week goes by that newspapers and television do not carry stories about spaceflight and cosmonauts. April 12, "Cosmonaut Day," is celebrated nationally. Indeed, cosmonauts are among the most revered people in the Soviet Union.

As Gorbachev has said about his country's launch site, "All of us Soviet people have always pronounced the word 'Baikonur' with special emotion. It has become a symbol of our homeland's greatest exploit—a triumph of Soviet science and the great potential of the socialist social system. Here in the boundless steppes of Kazakhastan, one experiences a sense of pride in the intellect and achievement of Soviet people, and in our Soviet homeland. . . . It was from here that mankind first stepped into space, opening a new page in the history of civilization. . .We do not intend to slacken our efforts and lose leading positions in space exploration."

A Soviet fantasy: If Tsiolkovsky were alive today, he would go outside on a clear evening (as he often did) to gaze upward to the stars. He would probably notice many tiny points of light moving slowly against the background of the heavens throughout the night. If he would ask which nation those satellites were launched from, the answer would be that over 80 percent were of Soviet origin.

Tsiolkovsky would be pleased. □

The health of U.S. industry depends partly on developing a pragmatic approach to engineering education.

Why We Need HANDS-ON Engineering Education

Worried about the declining competitive position of U.S. industry, many people are pointing to a crisis in engineering education. The majority see faculty shortages and outdated laboratories as the most critical factors. Therefore, they usually propose allocating more government funds to universities for both research and up-to-date equipment, on the assumption that more funds will attract more students to doctoral programs, which in turn will provide more engineering faculty.

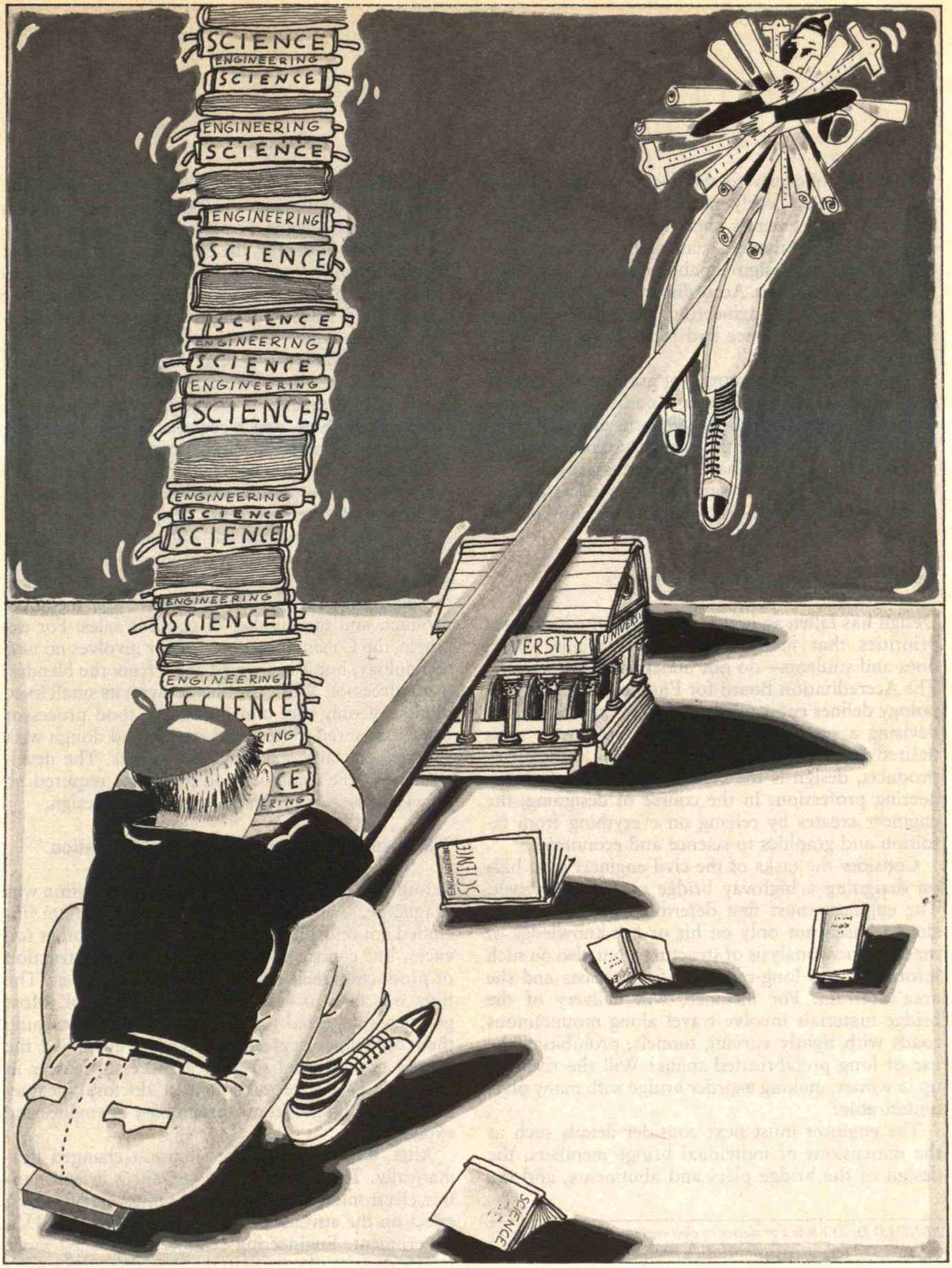
These "solutions," however, sidestep the real crisis in engineering education—namely, its emphasis on engineering science at the expense of engineering design. Engineers design products, structures, and systems, whereas engineering scientists develop the basic knowledge that engineers need. But that difference has become obscured in modern engineering education. As a 1986 National Research Council (NRC) review of engineering-college catalogs from the past 30 years disclosed, an "unmistakable trend of increasing science and engineering science content" has emerged in the curricula. Nam P. Suh, assistant director of the National Science Foundation (NSF), says in another 1986 NRC report that "while analysis in engineering science is an important facet of engineering, it is clear that we have neglected synthesis-oriented skills such as design."

As a result, potentially creative designers are either unchallenged or discouraged by the current curricula. Today the top engineering students are the top analysts, not the top designers.

We believe that the emphasis of engineering science over design has con-

BY ARNOLD D. KERR AND R. BYRON PIPES

ILLUSTRATIONS: EUGENE YELCHIN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tributed significantly to the decline of the nation's industrial base. Clearly many factors are at work—such as management's short-term financial objectives and labor practices that inhibit productivity—but the lack of design capability among U.S. engineers is predominant. According to yet another 1986 NRC report, U.S. engineering graduates no longer have the feel they once had for creating complete, functioning systems.

For example, the majority of graduating mechanical engineers cannot design a combustion engine. They may have studied the strengths and properties of various materials or the way gases flow and react in turbines, but they have not necessarily learned how the parts of an engine are designed, manufactured, and assembled—or even how the components work.

Design: From Graphics to Economics

Design has fallen so low in the order of educational priorities that many engineers—especially young ones and students—do not understand its meaning. The Accreditation Board for Engineering and Technology defines engineering design as "the process of devising a system, component, or process to meet desired needs." Essential to developing competitive products, design is the central activity of the engineering profession. In the course of designing, the engineer creates by relying on everything from intuition and graphics to science and economics.

Consider the tasks of the civil engineer who bids on designing a highway bridge over a wide river. The engineer must first determine possible bridge shapes based not only on his or her knowledge of mathematical analysis of structures, but also on such information as long-range traffic forecasts and the area's terrain. For instance, will delivery of the bridge materials involve travel along mountainous roads with tightly curving tunnels, prohibiting the use of long prefabricated spans? Will the river ice up in winter, making a girder bridge with many piers undesirable?

The engineer must next consider details such as the dimensions of individual bridge members, the design of the bridge piers and abutments, and the appropriate construction method. Again, he or she must rely on intuition and experience as well as a knowledge of science. For instance, if the soil at the river's edge is soft clay, the engineer must know that abutments will have to be placed on piles driven into firmer soil. If a suspension bridge is called for, the engineer will have to recognize that suspension cables are too heavy to weave off-site. So he or she will have to design a special platform for weaving the cables over the construction site. Then the engineer must estimate the total cost by conducting an economic analysis, which requires an understanding of the cost of materials and construction methods. Throughout this process, the engineer also has to recognize that aesthetics, cost, and local politics may determine whether his or her design will be chosen.

Similarly, the mechanical engineer's understanding of design know-how—including his or her ingenuity and knowledge of marketing needs—makes the difference between an innovative and mediocre product, and the number of possible sales. For example, the Cuisinart food processor involves no new technology, but it is a world apart from the blender, its predecessor. While the blender with its small fixed blade can only mix and puree, the food processor can chop, shred, puree, and even knead dough with a variety of large exchangeable blades. The development of the versatile food processor required no novel theories or analyses, just creative design.

The Waning of Engineering Design Education

Before World War II U.S. engineering education was pragmatic. A typical engineering curriculum included not only physics, mathematics, and other sciences, but courses in drafting, design, construction or production methods, and economic analysis. The tone was of a professional technical school. Most graduates expected to enter industry after earning their bachelor's degree. And those who joined the faculty typically did so after a successful career in industry. Few professors held a doctoral degree; rather, they taught from a broad base of engineering experience.

After World War II the situation changed dramatically. The great wartime advances in aeronautics, electronics, and nuclear technology had a strong effect on the attitudes of the public and on the U.S. government. Engineering schools introduced more mathematics and science in the curricula, along with

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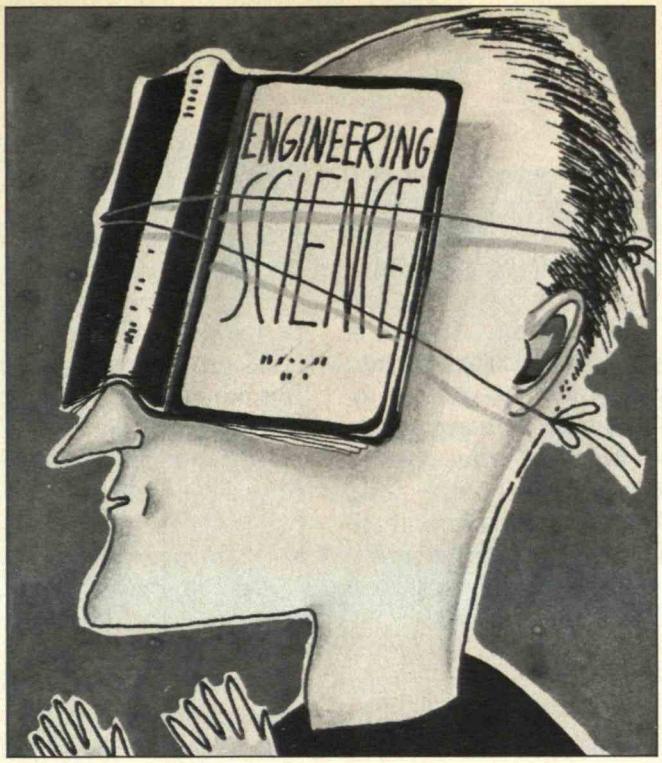
a greater emphasis on graduate study. Expanding or newly established government and industry research laboratories, such as the naval research labs, the U.S. Army Waterways Experiment Station, Bell Labs, and IBM Research Centers, afforded a ready market for science-oriented engineers, especially those with advanced degrees.

To make room in the undergraduate curricula for more science and mathematics, courses dealing with engineering practice were de-emphasized or dropped. They were least in step with the new trend. Many design programs deteriorated rapidly. An alternative would have been to add engineering-science departments while preserving the design-oriented programs.



Incoming faculty typically have little or no design experience.

Perceiving national interests to be at stake in the advancement of science and technology, the federal government indirectly financed the curriculum change by supporting engineering-science research at universities. Part of this support came through grants from the NSF, founded in 1950. From the late 1950s on, the greatest impetus for research came from space exploration and defense. Faced with the challenges of space flight and the manned landing on the moon, NASA initiated a broad program of funding university research. Other sources of support were created by the armed forces through their research offices: the Air Force Office of Scientific Research, the Office of Naval Research, the Army Research Office, and later the Defense Advanced Research Projects Agency. The practice of funding research at universities also spread to other federal agencies, such as the Department of Transportation and the Department of Energy.

The simple availability of such funds led university administrators and faculty to seek the grants. They were motivated as well by a desire to enhance the national reputation of their institutions. An essential step in this direction was to appoint recent recipients of doctoral degrees to faculty positions. These individuals were good candidates for grants because of their research training and their familiarity with the latest scientific advances.

The movement toward engineering science has become self-perpetuating. Research funds provide support for graduate students, who after graduation constitute the pool of young faculty members needed to continue expanding the research programs.

Incoming engineering faculty typically have little or no experience in design, yet they are the ones frequently expected to teach design courses. Often considering the classes a burden, these professors usually adhere to a standard design text and are unable to enrich courses through personal knowledge. To secure tenure, they generally do research in the engineering sciences, for which grants are available and results can readily be published.

The situation is growing worse as design professors with actual experience retire. Should the number and quality of design courses continue to drop, the engineering programs at U.S. universities will become, in our view, pre-engineering programs at best, insufficient to prepare students for the effective practice of engineering.

The primary force deterring this development is the Accreditation Board for Engineering and Technology (ABET). Since 1970 ABET has responded to industry's urgings by calling for a minimum design content in the engineering curricula. The board requires 12.5 percent of the total credits, or 16 semester credit hours, to be design courses. Almost all

universities have attempted to partially meet those requirements by claiming design credits within some nondesign courses. For example, a university may try to claim that one-third of the credit hours in a structural analysis course—which concerns the calculations of beams, frames, and arches—relates to design. ABET accreditation teams, however, frequently dispute faculty evaluations of what constitutes design. Currently, some organizations that belong to ABET are attempting to reduce its minimal design requirements. Actual design experience among those teaching the design courses has not even been an ABET condition.

The Harm to U.S. Industry

Employers report that new engineering graduates at all levels are often unable to contribute to product design teams and require extensive on-the-job training. Many of them "seem to have a total misunderstanding of the overall design process," wrote Edward G. Naumann last year in *Mechanical Engineering*. Naumann, a structural design manager for LTV Vought Aero Products Division, described a senior design project sponsored by LTV at a major university. The students were asked to design a rectangular exterior panel for an aircraft's fusilage, based on load requirements that Naumann prescribed. The final report contained extensive numerical analysis, but no drawings to specify the panel's proper dimensions. In fact, the students had not designed the panel.

"The vast majority of newly graduated engineers are trained for analysis positions and are rarely exposed to design engineering practices," says Frank M. Manders, chairman of the design engineering technical committee for the American Institute of Aeronautics and Astronautics.

In large corporations, young engineers can obtain design skills and knowledge by working in design groups. But this practice tends to be inadequate. The new engineer who learns from a group of experienced designers steeped in one company's approaches and style gains at best a narrow view of design. Another problem is that some industries such as the machine-tool and the automotive- and electronic-supply businesses are mostly comprised of small companies. While innovative design is key to their survival, they cannot afford the same on-the-job design training as large corporations.

New tools such as computer-aided design and expert systems cannot be expected, at least in the near future, to compensate for the lack of a thorough design education. These powerful aids can sharpen a design and test a large variety of options quickly. But much of engineering is based on techniques that involve intuition, experience, and common sense. Until artificial intelligence can capture the full range of such qualities, computer-aided methods will serve primarily as an adjunct to engineering creativity, not a substitute.

U.S. engineering graduates' lack of exposure to design and manufacturing partly explains the country's disadvantage in developing well-designed and well-manufactured products. We find it telling that General Motors relied on German engineering to design the 1988 Pontiac LeMans. (The company even advertises that fact!) Or consider the way the president of one American company located a contractor to design a videocassette recorder—a technology based on U.S. engineering research. He went to several well-known American audiovisual firms but could find none that was qualified or willing to undertake the task. The knowledge required to design mechanical systems of this type seems rare among American engineers. Reluctantly, the executive went to Japan, where he quickly found the necessary expertise.

How Other Nations Train Engineers

It is useful to examine how West Germany and Japan structure engineering education. In West Germany, technical university students primarily take mathematics, physics, chemistry, and "technical"—or applied—mechanics during their first two years. In the two to three remaining years the curriculum emphasizes design courses taught by professors who are generally outstanding engineers from industry.

In Japan, undergraduate engineering curricula are much more like those in the United States. Design is not emphasized, especially at the prestigious national universities. The difference comes after graduation. The Japanese company—at which an employee may stay for his or her entire career—provides its engineers with intensive design training for as long as two years, both in the classroom and on the shop floor. In addition, design teams often oversee a product all the way through production—a practice that greatly enhances an engineer's insight

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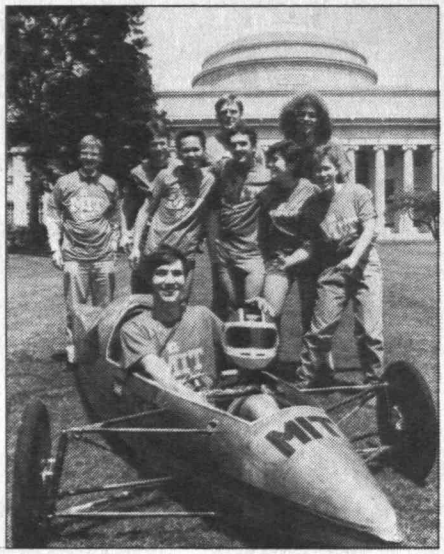
ABOUT THE COVER
Wedged snugly into the cockpit of the solar-powered car he designed, built, and raced with the help of a team from the mechanical engineering department is James Worden, '89 (see right).
(Photo: Donna Coveny)

Solar-Powered Entrepreneur



The low profile that James D. Worden, '89, had cultivated for the past two years and more was shattered on the night of June 15, when his solar-powered one-seater, *Solectria IV*, nearly outran his police escort in a midnight test run on the streets of Arlington, Mass.

The police blotter, which recorded the escorts' astonishment at the 50-mph pace, led the *Boston Globe* and the *Arlington Advocate* to the story, and then Worden went public.

With help from the Mechanical Engineering Department, UROP, and a score of commercial supporters, Worden had spent much of his sophomore year as a mechanical engineering major building his fourth solar-powered car. Now he planned to take *Solectria IV* to Switzerland for the six-day, 250-mile Tour de Sol solar car race in late June. It would be the only American entry in the race, pitted against some 120 European-made vehicles.

Worden has been fascinated with solar-powered vehicles since high-school days in Arlington, and he wants eventually to become "the Henry Ford of solar automobiles." All he needs, he says, is a little more technology and a lot of venture capital.

After his June 15 test, Worden was optimistic. "It was a lot better than last time," he told Dana Gardner of the *Arlington Advocate*. "We think there's a really good chance (of winning)."

But it was not to be. Less than an hour after the race began in a village near Bern, Switzerland, with *Solectria IV* running eleventh in the field of 120, Worden had to pull over.

"There were a few small flames and lots of smoke coming from the back," he says.

Worden's team of four undergraduates, two graduate students, and Professor Harry West, Ph.D.'85, flew into action. The streamlined body was stripped and the fire put out in moments, and the verdict came in soon after: a seized transmission had overheated a motor, with minor repercussions in the electronic controls.

West remembers what followed as a "truly extraordinary" scene. On the roadside grass of a tiny Swiss village, with other contestants speeding by, *Solectria IV*'s transmission was completely disassembled, cleaned, and rebuilt. Four hours later Worden was back on the road.

"Any other team would have given up," says West.

The next day with its motors replaced but without its streamlined shell that couldn't be salvaged, *Solectria IV* passed 40 cars, to improve its position dramatically. But the first day's delay ruled out ultimate victory.

For the technically inclined among our readers, here are *Solectria IV*'s principal specifications: Dimensions: 12 feet long, 6 feet wide, 2.25 feet high; frontal area about 5 square feet, weight without driver, 350 pounds. Body: carbon graphite composite foam sandwich; frame: thin-walled steel tubing, braced and silver soldered; wheels: two front, one back. Brakes: 4-inch internal expansion drums on all wheels plus an additional disc brake on the rear wheel. Power: 46 square feet of solar panels providing 480 watts (48 volts) at 25 C. in full sunlight; 100 ampere-hour battery, 4,800 watt-hour capacity, weight 185 pounds; motors: three 1.3 kw. DC, efficiency 91 percent at 4,500 rpm and full load; transmission: five-speed, three-level, overall ratio 3.5:1, efficiency 96 percent. Instruments: ammeters, voltmeters, speedometer, odometer, and safety indicators. □

PHOTO: DONNA COVENEY

UNDER THE DOMES

Launching the Campaign

A plethora of events will mark the opening of a major capital fund campaign for M.I.T. on October 22, 23, and 24.

Members of the Corporation and its guests, including the Corporation Development Committee, will attend a formal reception and dinner on Thursday, October 22, to be followed on Friday morning by the annual meeting of the CDC.

Alumni attending the 1987 National Alumni Conference will join CDC members and interested members of the M.I.T. community on Friday afternoon, October 23, for a series of faculty symposia under the general title, "What in the World Is Going On?" (*see box below*). NAC and CDC guests will share a gala dinner-dance on Friday evening. That will be followed on Saturday with the traditional National Alumni Conference events: annual meeting of the Alumni Association, awards luncheon, Institute open house, and President's reception.

Open house events will include intercollegiate and intramural athletics, campus tours, and several high-interest laboratories.

Further details: Joseph J. Martori, associate secretary of the Alumni Association, Building W59, M.I.T., telephone (617) 253-8230. □

Class of '91 Arrives at a "Gold Mine"

At press time, 986 men and women, chosen from 6,503 applicants, had arrived on campus to embark on a new life as the Class of 1991.

Even by M.I.T. standards, it is an outstanding class, says Daniel T. Langdale, associate director of admissions. Fully half had scores higher than 750 on the College Board mathematics achievement test—level II, on which a perfect score is 800. More than 80 percent were in the top tenth of their high school classes. Nearly 20 percent were elected school or class officers, and 50 percent were officers of school clubs and organizations.

The Class of 1991 will have as many women as last year—some 37 percent—and more racial minorities. Foreign students, including Canadians, will be just under 10 percent of the total, according to Langdale.

Almost half of the freshmen scored above 650 on the College Board verbal aptitude test, compared with 40 percent in the Class of 1990. The jump clearly results from the effort to increase diversity among M.I.T. undergraduates outlined by Michael Behnke, director of admissions, on these pages in July (*see MIT 10-13*).

Greater diversity is evident, too, in the academic interests of the new class. Two-thirds of them have indicated that they plan to major in engineering, and one-third of these are thinking of electrical engineering. Both figures are lower than in previous years, and both are certain to change before the end of the 1987-88 year, when most will declare majors.

Hence the advice of Ira Haimowitz, '88, in the 1987 Freshman Handbook: "You now have access to one of the most exciting intellectual centers on earth," wrote Haimowitz. "Every department is world class. . . . This place is a gold mine. Dig!"

Similar advice from Professor Samuel J. Keyser, associate provost: "It is not unusual to hear people talk about a difference between 'hard' and 'soft' disciplines," wrote Keyser. "(But) this division is at best not very useful and at worst very misleading. . . . When you decide which particular discipline to study, do so on the basis of what questions it seeks to answer and what questions interest you. Whatever you do, avoid the 'hard'/'soft' trap.

"At the boundaries of our knowledge all of our questions are hard and all of our answers are soft."

Half of the class receives financial aid in the form of grants, loans, and/or employment opportunities—a total of over $7 million. Sixty percent of the class worked part-time as high school students, and more than half had full- or part-time summer jobs. □

"What in the World Is Going On?"

The following are the topics of reports by M.I.T. faculty to be given for alumni and other guests on Friday, October 23:

"Buildings to Atoms: Automated Precision Manufacturing," Professor Alexander H. Slocum, '82.

"Organizational Structure and Artificial Intelligence," Professor Thomas W. Malone.

"The Superconductor Revolution," Professor David A. Rudman.

"Biotechnology: The New Frontier," Professor Daniel I. C. Wang.

"An Historian's Perspective on the Middle East," Professor Philip S. Khoury.

"Changing Patterns of R & D in Japan," Professor D. Eleanor Westney.

"Chemistry: Molecules That Matter," Professor Mark S. Wrighton.

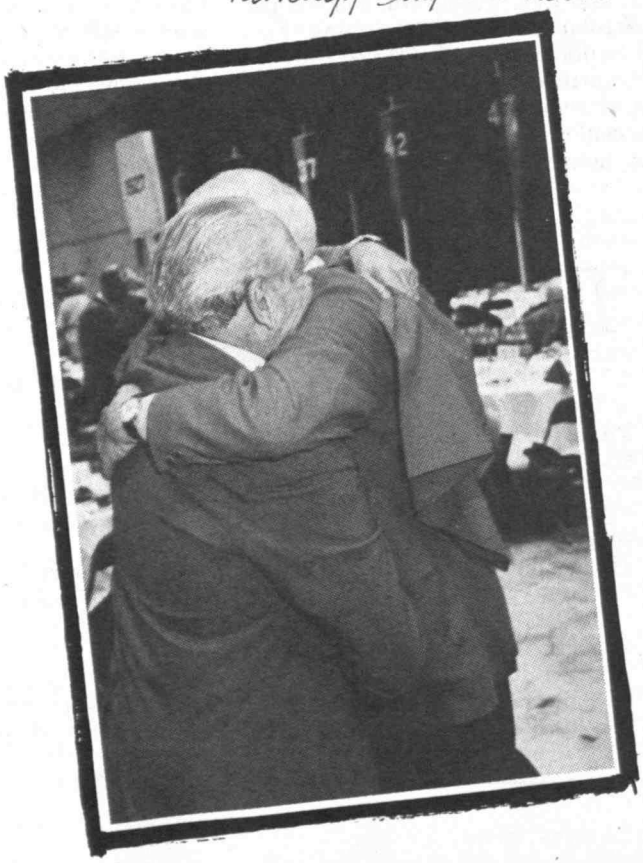
"City Marketplace: Dealmaking to Rebuild Downtown," Professor Bernard J. Frieden, Ph.D.'62.

"A New Agenda for the M.I.T. Undergraduate Program," Professor Margaret L. A. MacVicar, '65. □

The Class of '57 clambake brings old friends together.

Edwin Rosenberg, '47, discovers that Martha Munzer Corkland, '22, his high school chemistry teacher, is also an M.I.T. grad.

a warm embrace at the Technology Day luncheon.



Reunions are only the occasion, renewed friendships are the substance.

Some 2,000 alumni and their guests assembled for Pops and the Technology Day Luncheon, the two most quintessential Reunion events. They then reconvened in 13 quinquenial (every five years) reunions, at more than 107 separate events. They went from a clambake in woodsy Wenham to black tie at the Boston Marriott, from Vermont to Cape Cod; they watched whales and danced to 70s music. It sure looked to us like they had a good time. □

Reunion Gifts Set New Records

Reunion gifts of more than $14 million announced at the Technology Day luncheon before some 1,200 alumni, spouses, and guests led President Paul E. Gray, '54, to observe that the Institute's alumni "are as generous as they are smart.

"M.I.T. has become what it is by virtue of the strengths of its students. That's true of the past," said Gray, "and it's just as true today. By your gifts you state your pride in what you did and what we do here."

The gifts from the three major reunion classes of 1937, 1947, and 1962 totaled about $10.5 million—the total of gifts from these classes during the five years preceding the reunions and pledges to be paid in the five years following.

The largest of these came from the 50th reunion Class of 1937—$4,787,000, the second largest 50-year-gift in M.I.T. history. The fund-raising effort, in which 76 percent of the class participated, was led by Chairmen Joseph F. Keithley and George S. De Arment, who substantially exceeded their original $4 million goal. In addition, 29 members of the class have indicated their plans for $1,830,000 in future gifts.

The Class of 1947, led by Harl P. Aldrich, Jr., and class President Claude W. Brenner, announced a record 40th reunion gift of $3,007,000, with 68 per cent of the class participating. The reunion spirit had been persuasive, Aldrich said: there were new pledges of $74,000 in the 18 hours immediately before the luncheon. Of the total, Aldrich reported, $443,000 was designated for a Class of 1947 professorship.

When his turn came, gift chairman Edward H. Linde announced with pride that his Class of 1962 had "gone to extremes to prove that records are meant to be broken"—a record 25th-reunion gift of $2,661,000. That was nearly $500,000 more than any previous 25-year gift, contributed by 66 per cent of the class.

In addition to these three major reunion gifts covering five-year periods, there were one-year giving announcements from six classes:

□ The 60th-reunion Class of 1927, led by Chairman Russell P. Westerhoff, contributed $2,169,000.

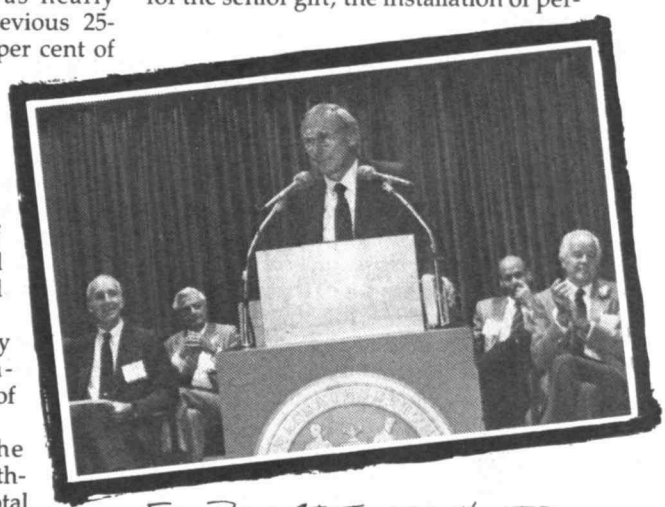
□ The Class of 1922, led by Theodore T. Miller, announced a 65th-reunion gift of $2,013,000.

□ Linda Y. Mayeda led the Class of 1972 to the first 15th-reunion gift ever made—a total of $96,895. It included $33,865 to support undergraduate research that seeks to "improve the quality of life through its impact on society and/or the environment." Forty-one percent of the class participated.

□ The 10th-reunion gift chaired by Carol C. Martin also set a new record, raising more than $55,000. Nearly half the amount is to establish a permanent Class of 1977 student aid fund.

□ The 5th-reunion gift campaign of the Class of 1982, under Juan Edwardo Torres Pasos and Peter W. Vedder, raised $24,500, with 68 percent of the class participating.

□ Gifts and pledges of $34,670 came from the Class of 1987, including funds for the senior gift, the installation of permanent directory maps and announcement boards on the campus.



For Ray Stata, '57, the T-Day luncheon was his first appearance as president-elect of the Alumni Association.

Alumni Association President for 1986-87 Joseph G. Gavin, Jr., announced

President Paul Gray, '54, spotted many old friends at Pops.

that the 1987 Alumni Fund stood at an all-time record of $12.6 million, already $600,000 over its goal. Already there were contributions from 25,000 alumni, he said, and the books were to stay open for several more weeks.

Accepting the funds, President Gray told the alumni that "those of us who labor in this vineyard of higher education every day have a special gratitude for your gifts. . . . Although you and I are proud of and benefit from the fact that our alma mater ranks among the top half dozen or so American universities, the truth is that we have a host of needs ranging from endowed professorships, fellowships, and scholarships to new buildings, dormitories, and seed money for research.

"Ours is an expensive kind of education," he continued. "If you knew the struggle and sacrifice families go through to keep their sons and daughters here these days—and many of you do—you would begin to grasp the dimensions of our need for increased student financial aid."

Gavin, who served as master of ceremonies for the Technology Day luncheon, announced that alumni representing 75 classes were present. The most senior alumnus, he said, was Walter P. Muther, '13, celebrating his 74th reunion.

Also singled out for special mention were: Horace W. McCurdy, '22, and Mrs. McCurdy, celebrating his 65th reunion and also their 65th wedding anniversary; Frank Sidney Badger, Jr., '27, and Mrs. Badger, celebrating his 60th reunion and also their honeymoon; and Raymond Wong, '52, of Kuala Lumpur, Malaysia, who traveled the greatest distance to attend his reunion and Technology Day.

Coveted honorary memberships in the Alumni Association were awarded to Winifred T. McDonough, recording secretary of M.I.T., and Dorothy G. Adler, coordinator of alumni recognition and selection processes. McDonough was honored for providing "with quiet efficiency . . . the major linkage between donors and the Institute . . ." and Adler as "straw boss of staff and volunteer alike" in her many Alumni Association assignments.

Finally, to end his duties as 92nd president of the Alumni Association, Gavin turned over his gavel to Raymond S. Stata, '57, who on July 1 became Gavin's successor. Stata is chairman, president, and cofounder of Analog Devices Inc., Norwood, Mass. □

1962's 25th Reunion: Postmortem on the First Half of the Game

By John Mattill

A reading of the 1962 *Technique* suggests that by modern standards the Class of 1962 was a pretty traditional bunch. Items:

□ The official close of the "May Day riot" was the burning of Castro in effigy.

□ At mid-year the Interfraternity Conference decreed that all materials mailed to rushees must go out at bulk postage rates—at an estimated saving of $90 per year, per fraternity.

□ When WTBS began FM broadcasting on M.I.T.'s Centennial Day, President Julius A. Stratton, '23, and Dean John T. Rule, '21, came to the studio to make congratulatory addresses on the air.

□ The piece de resistance at Field Day was a human-powered chariot race, the chariots being adorned by young women in Roman costumes.

By the time the Class of 1962 returned for their 25th reunion last June, the question of their conventionality seemed—at least to one observer—to be in doubt. I thought the reunion-goers were a little less traditional, a little less intense about high-tech competitiveness, than some of their recent counterparts. Consider, for example:

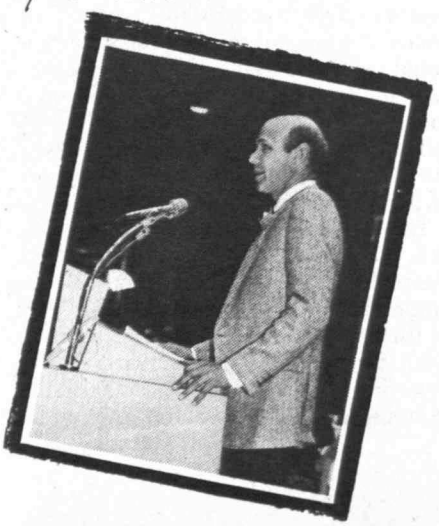
□ A successful vintner in California, David S. Stare, '62, sent enough of his cabernet sauvignon and chardonnay to fill every classmates' glass at every reunion celebration.

□ Lane Anderson, '62, brought his cello all the way from Monaco in the airplane seat beside him to play at the class banquet at the Museum of Fine Arts. He is principal cellist with the Monte Carlo Philharmonic.

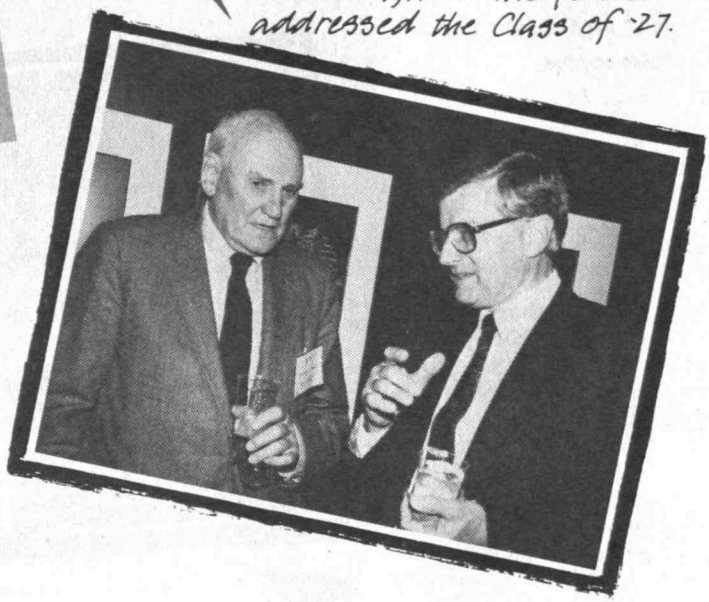
□ Robert A. Hirschfeld, '62, sold a successful high-tech start-up in 1977, went to law school, passed the bar exams at the age of 44, and now is practicing in Phoenix, Ariz. He specializes in child custody cases and single fathers' problems, and accordingly he was the editor and publisher of *Single Dad's Lifestyle* magazine from 1978 to 1983.

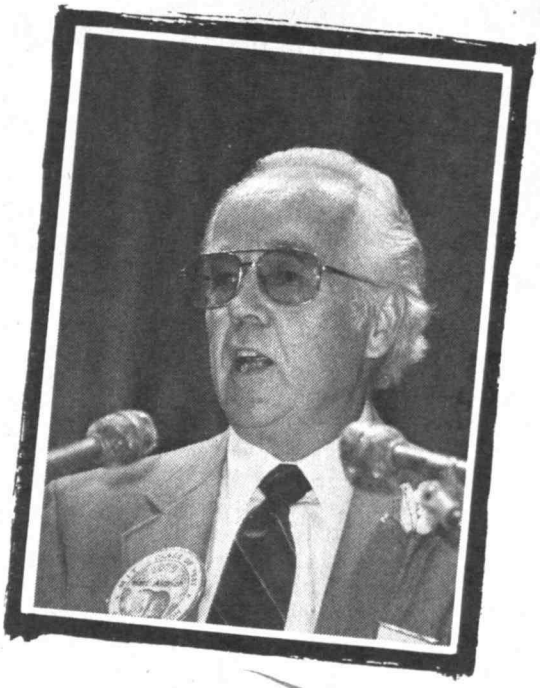
□ Arthur T. Funkhouser, '62, graduated in physics, but as a Jungian psy-

Edward Linde, '62, Reunion Gift Chairman, presented his class' good news.



Kenneth A. Smith, '58, (right) Vice-president for research at M.I.T., met Kenneth A. Smith, '27, dean emeritus at Columbia (no relation!), when the former addressed the Class of '27.



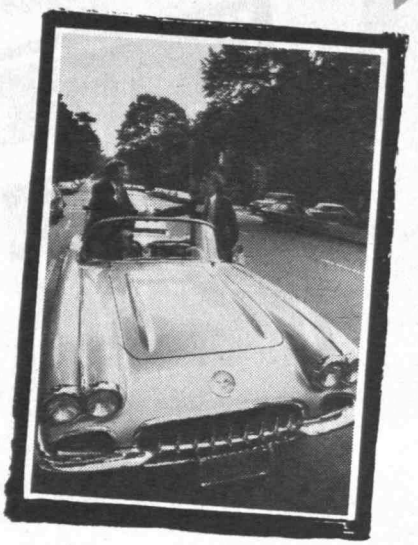


Above: Harl Aldrich, '47, 40th Reunion Gift Chairman.

Winnifred McDonough (left) and Dorothy Adler, new honorary alumnae.

Below: Chairman of the Corporation, David Saxon, '41, joined the Class of '27 for dinner at the M.I.T. Museum.

Vintner David Stare, '62, provided the wines for his class' 25th reunion.



chologist he helps patients find meaning in their dreams (*p. MIT 40*).

On the other hand, the titles of many of those whose thumbnail sketches appear in the 25th reunion book connote mainstream careers—president, founder, partner, director, vice-president, consultant, professor, CEO . . .

David H. Koch, '62, claims the "highest political aspirations of anyone in the class": he ran for vice-president of the U.S. on the Libertarian Party ticket in 1980, when he collected 1 percent of the vice-presidential votes.

But then there is Alan Cameron, '62, who wrote on his questionnaire that his "proudest achievement" was being elected selectman of Carlisle, Mass., population 4,500. And Leslie Evenchick, '62, remembers with most pride the moment when a 12-year-old called him "the best friend a person or an animal could have."

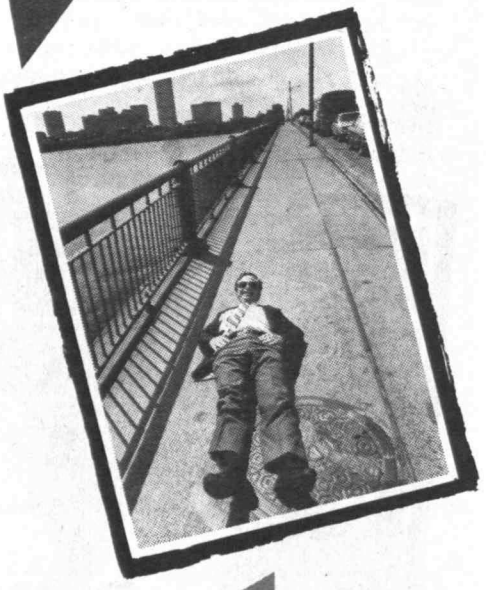
Martin Klein, '62, has been involved in all kinds of exotic enterprises—finding shipwrecks and nuclear warheads on the sea floor, oceanographic expeditions to every part of the earth. He's a fellow of the Explorers Club. But his interest in the sonar systems on which he's built such an exciting career began with a routine (for M.I.T.) event. Klein still remembers how, as an undergraduate, he stumbled onto Professor Harold E. Edgerton's "Strobe Alley" and asked Doc, "Do you have anything to work on?" Klein Associates has been built on the thesis project Doc suggested—sonar as a tool for "making the ocean transparent," says Klein.

Robert Burns, '62, is a syndicated financial columnist for the *Dallas Morning News*. He was a maverick at M.I.T. almost from day one, he recalled, until he finally realized that he didn't want to be an engineer. So he switched to writing and submitted a novel as his bachelor's thesis. "If I had it to do again," Burns told his classmates, "I'd work less and enjoy it more."

The assembled classmates cheered when Thomas J. Greytak, '62, who has stayed at M.I.T. to become professor of physics, said that today's freshman classes are 35 percent women—a far cry from the 15 women who registered in the fall of 1958. More cheers when Greytak compared the success rate at M.I.T. of the Class of 1962 (70 percent of those who entered received degrees) with that of recent classes (86 percent).

But booing and hissing prevailed when Greytak reported the most prevalent grade given undergraduates at M.I.T. in 1987 was A—39 percent of all grades. Back in 1962 the most prevalent grade was C, and only 17 percent of all grades were A's.

There wasn't—and isn't—anything very unusual about Oliver Smoot, '62, but his name is now an M.I.T. legend. A plaque to prove it, presented during



Oliver Smoot, '62: starting across the Harvard Bridge in classmate Jan Hyde's 1962 Corvette and rechecking his 25-year-old height marks.

Far left: Cellist Lane Anderson, '62, of the Monte Carlo Philharmonic.

Left: '62's festive Kennedy Museum banquet.

the reunion, will be placed on the rebuilt Harvard Bridge when it's opened to regular traffic, estimated to happen in 1989.

Smoot's M.I.T. career was easily described in three lines in the 1962 *Technique:* he majored in economics and mathematics, worked on *Voo Doo* for one year and with the Interfraternity Council for two years, and pledged Lambda Chi Alpha. Smoot is now executive vice-president and treasurer of the Computer and Business Equipment Manufacturers Association in Washington. None of this explains his notoriety on the Boston-Cambridge axis.

Indeed, he insists that his fame was not his fault. It resulted from the decision of his fraternity brothers—no one remembers why—to use Smoot's height as a unit of measure for the length of the Harvard Bridge. So as part of his Lambda Chi Alpha initiation, Smoot was laid head-to-toe, head-to-toe, from Boston to Cambridge.

The job done, nothing much happened for a few years. But by now repainting the 10-smoot markers on the bridge, which is a total of 364.4 smoots and one ear long, is a pledge-week tradition at Lambda Chi Alpha. Thus is the story of Smoot's fraternity initiation perpetuated among the legends of M.I.T.

Smoot's re-enactment of the episode during the reunion, proving that he is still 1 smoot tall, made the wire services on June 6. That extra fraction of a smoot called an ear? His ear, Smoot guesses, but he can't remember.

G. Mead Wyman, '62, reunion chairman, had a nice way of describing what he saw during the reunion weekend. It's been like sitting in the locker room with the game half over, he told classmates as the festivities ended. "We've finished the postmortem on the first half. But the present is only a prelude to the future," said Wyman, "so let's bring on the second half."

In their enthusiasm, his classmates elected Wyman to take charge of that second half as new class president. The incumbent, Chenery Salmon, '62, declined re-election because of the pressure of business. □

T-Day Features Athena

Project Athena, M.I.T.'s pioneering effort to use networked computers to enhance learning for undergraduate students, now involves some 125 academic projects.

Each project focuses on a very specific subject, such as electromagnetic field theory or thermodynamics, or very specific educational tasks, such as recording and analyzing data collected by laboratory equipment or establishing a design environment in architecture and planning. But taken together, the projects attempt to deal with some of the thorniest problems in teaching, according to Athena Director Steven Lerman, '72.

Speaking to some 1,000 alumni at the Technology Day program, Lerman listed several of the areas where students traditionally experience difficulties that faculty hope the special characteristics of the computer can help them address:

□ Visualization of very abstract concepts.

□ Translation of mathematical formulations into intuition, i.e., "If I change a variable in this complex system, I can expect the system to react in this general way."

□ Creating realistic design experiences that close the gap between student design problems and those in industry.

□ Dealing with vast quantities of data and teaching students to distinguish between data and information (data that has been digested and is useful for decision-making).

□ Individualization of learning.

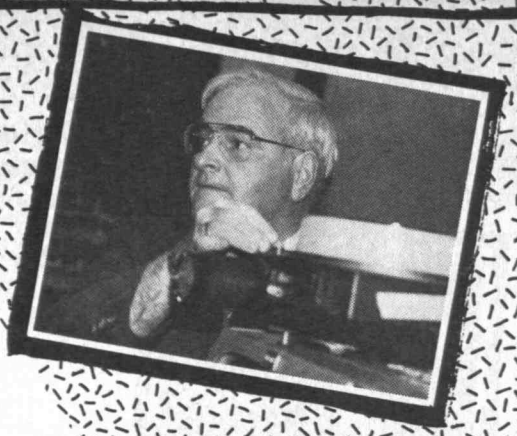
Case in point: the teaching of thermodynamics was traditionally limited by the difficulty of the computations—students could only work with examples that came in a closed form that they could handle. Now, Joseph Smith, Jr., Sc.D.'59, professor of mechanical engineering, told the T-Day audience, his department is developing the software that will enable the student to work with problems that more closely model the real world.

The problems in language teaching are not unrelated to those in thermodynamics, namely, how can we equip students to handle reality, not just classroom problems? "When you get to Paris," Janet Murray of the Writing Program said at T-Day, "*nobody* is speaking Intermediate French!"

Murray went on to describe the Athena Foreign Language Project, one of the flagship developments of the program. First they digitized speech, Murray said, creating spectographs—visual representations—for the sounds needed in a language such as French or Spanish. The computer can then digitize and display a student's utterance, display the model spectograph, and the student can see for herself how close she is to the model utterance.

The Foreign Language Project is attracting a lot of attention for LNGO, its interactive video program that will also be used at Harvard, Middlebury College, and the Air Force Academy. Using LNGO, the student can instruct a poltergeist to "trash" a room and then clean it up again, go through the exercise of locating and renting an apartment in Paris (using video images to "walk" through prospective units), or participate in a drama with a character who has amnesia.

Athena has broken new ground in technology as well as pedagogy with the development of the "X" window system. The X window standard has been adopted by every major workstation manufacturer in the world, Lerman said. □



Bill Noz, '57, enjoyes the fruits of his labors as reunion chairman—lobster all around.

Members of the Classes of '20 and '32 break into well-remembered song.

Members of the 50th and 25th reunion classes attend president's receptions.

Far left: When "Doc" Edgerton, 27, put on a slide show for his classmates at his 60th reunion, he had a very competent electrical engineer at the projector (left), but the name escapes us.

What 1962s Report About Themselves

To spice conversations at the Class of 1962's 25th reunion, chairman G. Mead Wyman and his reunion committee sent their classmates a questionnaire that asked them about almost everything. Though some of the questions may have seemed rather personal, anonymity was maintained. So there was general delight when Wyman summarized the responses from over 100 alumni at the closing brunch of the hugely successful reunion. Here's a summary of his summary.

Some 45 percent of the class came from New England, 10 percent from the West Coast. Now two-thirds of us live in different parts of the country than we came from; New England, the middle Atlantic states, and the West Coast have all received more than they gave.

Almost 90 percent of us live in our own homes, and two-thirds of those homes have small or no mortgages. In addition, 20 percent of us own vacation homes. Many of us (40 percent) have lived in our present homes for more than ten years. We live mainly (55 percent) in the suburbs, 18 percent in large cities, 12 percent in the country.

Sixty percent of us own an American car, 44 percent a European car, 41 percent a Japanese car. Fifteen percent own a motorcycle, 18 percent a sailboat, 10 percent a power boat, 67 percent a bicycle, 48 percent skis. Owners of roller skates are slightly more numerous than owners of garden tractors.

Of those married, 78 percent have been married only once, 19 percent twice. Of those who have children, 43 percent have 2, 38 percent 3, and 6 percent 4 or more. Five percent of the class are already grandparents. Fifteen percent admit to extra-marital affairs.

The class rates itself as "very healthy"—reasonably satisfied with weight, normal blood pressure. Pretty good sex life but a number of people just didn't want to talk about it. Some 80 percent take alcohol regularly or occasionally, only 10 percent smoke; 75 percent have never tried marijuana and 95 percent have never tried anything stronger.

Very few—7 percent—have ever been mugged. Fifteen percent admit to cheating on their income taxes.

Job descriptions: 25 percent general management, 20 percent education; 18 percent research and development; 14 percent entrepreneurs, 10 percent consultants, 9 percent physicians. Nearly half have up to 25 people reporting to them, 17 percent have 26 or more people to supervise. All work hard—84 percent between 40 and 60 hours a week at the office and 59 percent up to 10 hours a week at home. Only 12 percent never bring work home.

Half the members of the class have started businesses, and 75 percent of those have succeeded.

Few—almost none—have ever been involuntarily unemployed; 70 percent have never been fired.

No one now makes less than $20,000 a year, and only one member of the class earned that much upon graduation (but that was probably because he stayed in graduate school so long). Some 20 percent of those who responded to the questionnaire are millionaires.

Eighteen percent are still with the organizations that gave them their first jobs. Only 10 percent have worked for more than six employers in 25 years. Forty percent changed fields after leaving M.I.T.

On a scale of 5 (high) to 1, 43 percent rate career satisfaction at 4, 25 percent 3, 14 percent 2 or 1.

If they had it to do again, 75 percent would go to M.I.T. Nearly 90 percent think their M.I.T. preparation was especially beneficial, and 80 percent think they benefited from M.I.T.'s reputation. Two-thirds would encourage their children to go to the Institute.

When it comes to priorities, family is typically first, career second. Then come hobbies, sports, and community activities. Politics is at the bottom of the list. Most frequently mentioned recreations: reading, skiing, hiking, jogging, swimming. Many have built a building by hand, and—remarkably—many have saved a life.

Twenty-three are authors of published books, five have written a novel, six have had a poem published. Three-fourths of the class have written computer programs, 24 percent have one or more patents. Eleven have testified before Congress.

An even distrtibution as to politics: 32 percent call themselves liberal, 32 percent are in the middle, and 35 percent are conservative or conservative-leaning. Of spouses, 44 percent are liberal, 26 percent middle, 30 percent conservative. Most are skeptical about SDI, UFOs, and ESP, and we simply do not believe in astrology, faith healing, fortune cards, ghosts, life after death, palmistry, and water divining.

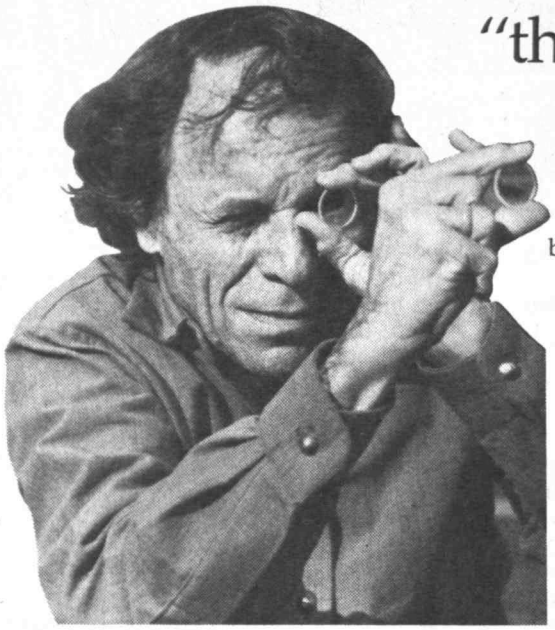
John H. "Murph" Murphy (left) was speechless with surprise after Mead Wyman, '62, announced that the equipment room in the Athletic Center would be named after him, sponsored by the Classes of '62 and '57 and the Athletic Department.

PBS

Science series airs beginning on October 20.

How Science Achieves "the Ring of Truth"

BY JEANNE McDERMOTT



A pile of half-charred, sugar-sprinkled, red-jellied doughnuts occupies the grate inside the fireplace of Philip and Phylis Morrison's home on a Cambridge back street, not far from Harvard Square. Do the Morrisons heat their home with leftovers? No, Morrison explains with a gleeful smile, this is the way they demonstrate the principle of energy conservation in their six-part television series, "The Ring of Truth," which will be a major feature on Public Broadcasting stations beginning on Oct. 20.

In the grueling 2,000-mile Tour de France bicycle race, each cyclist burns the calories in 32 jelly doughnuts each day. But only 8 to 10 of those jelly doughnuts are actually converted into the motion of the bicycle. The body releases the rest as heat.

How much easier it is to swallow the abstract concept of energy in jelly doughnuts than in megajoules—and, of course, how much more fun!

"The Ring of Truth" will bring the Morrisons' simple and elegant vision of science into living rooms across the country. Its preparation has been Morrison's chief preoccupation since before he retired from full-time teaching in the M.I.T. Physics Department to be Institute Professor Emeritus early in 1986.

The series will begin with Galileo's development of the telescope and wind up at the very brink of today's knowledge in astrophysics and quantum mechanics. Glassmakers in Italy, geologists in the American Southwest, magicians in Boston and astronomers in Arizona, geologists on a drill ship in the Mediterranean . . . the series spans the globe as the Morrisons lead an intrepid journey through the inner workings of science. There will be six segments in evening prime time—on October 20 and 27 and November 3, 10, 17, and 24. Major funding came from Polaroid Corp., celebrating its 50th anniversary.

For the last five years, the Morrisons, working with executive producer Michael Ambrosino (whose accomplishments include originating the *Nova* and *Odyssey* series for public television), have been setting a pace that would slow much younger people. To produce the series they traveled to such places as Natchez, Miss., and San Francisco, France and the Mediterranean, Venice, Yellowstone National Park, and even a stretch of Route 183 in Kansas that is the longest, straightest north-south road in the country.

Morrison is the on-camera guide, appearing the way he does in the classroom, betting and wagering ideas, retracing the detours that led to discoveries, and reliving scientists' intellectual eurekas. He inspires something that is at once quite ordinary and quite magical: he gets people to wonder.

"The Ring of Truth" takes its name from the old-timers' practice of determining the authenticity of a coin by listening to its ring. If the coin rang out brightly, it might be made from precious metal. But like most tests, the ring-of-truth was not foolproof; it was just a good first step.

The title is an apt one; the series' subject is really epistemology—how we know what we know. "Commercial television tells us what to believe," explains Ambrosino. "Our aim is to give the audience instruments with which to do their own viewing of the world."

For over 30 years, the Morrisons have challenged the way that science is usually taught—as a collection of dull, cold facts to be memorized, a foreign vocabulary to be mastered, and disciplines with unwavering laws to be respected. Their collaboration (and marriage) dates back to the mid-1950s when Philip, then a physicist teaching at Cornell, and Phylis, a schoolteacher and illustrator, met while revamping science texts for the public schools. "We were so appalled," says Philip. "A typical question was to distinguish a galvanoscope from a galvanometer. I tested ten physicists and none of them could do it."

In the wake of Sputnik, when the United States gave science education a top priority, the Morrisons devoted major efforts to helping improve the teaching of science in elementary and junior high schools. According to Ray Hannapel, science educator at the National Science Foundation, "Phil had nothing less than an enormous influence in bringing authentic, simple, elegant science activities into the classroom for young children."

Morrison joined M.I.T.'s faculty in 1965, when the Institute was a center of educational innovation in high-school physics curricula. He was associated from the start with the Physical Science Study Committee and became co-author of its novel secondary-school text. In recent years, Phylis, a teacher of science and art, has been his collaborator as an author and as a disarmament advocate as well as on this PBS television series.

"The Ring of Truth" will enable viewers to experience the Morrisons' special brand of science communicating—making science an experience and at the same time understandable by making the viewer a participant.

"Viewers have a role to play," says Morrison. "They must attend to what's going on. Then they can decide whether what we present has the ring of truth." □

JEAN McDERMOTT was a Bush Fellow at M.I.T. in 1984-85; she is the author of The Killing Winds: The Menace of Biological Warfare, *Arbor House, 1987.*

PHOTO: VITTORIANO RASTELLI

ASSESSMENT AND CHANGE IN UNDER-GRADUATE EDUCATION

Eight of its advocates describe the initiative that seeks to redefine a liberal education for a technological age. But "the journey is only begun," Dean Margaret L. A. Mac Vicar writes; M.I.T. is only two years into a 10-year process.

PHOTO: MARK ALTBUSH

"Why Are We Here Today?"

BY MARGARET L.A. MAC VICAR, '65

DEAN FOR UNDERGRADUATE EDUCATION

PHOTOS:
NEWS OFFICE
CALVIN CAMPBELL,
DONNA COVENEY

You have perhaps heard, or read, that M.I.T. is shaking up its undergraduate program. If you heard that we have a new program all mapped out, however, you were misled. We are only about two years into a ten-year process.

Curriculum assessment and change are at once objectives in themselves and moves toward our larger objective of changing the M.I.T. culture and attitudes. Perhaps the most important thing we are about is the process itself. How do we move a large institution in new directions without losing its distinct and valuable qualities?

What we think we are doing and why we are considering changing an educational program acknowledged to be one of the best in the world is the subject of this series of essays in *Technology Review*.

The essays are all based on presentations first aired at a forum on undergraduate reform I convened last May. The forum included Provost John Deutch, '61, Associate Provost Jay Keyser, the school deans, administrators like Director of Admissions Michael Behnke and then-Director of the Undergraduate Academic Support Office David Wiley, '61, other members of the faculty, and students.

In convening the forum I asked the speakers to share their present understanding about the need for assessment and change in the undergraduate academic program—however the process appeared to them—to pose questions, and to comment on the agenda for the next few steps or the long term.

It was not a tidy session. Visions of the future are never tidy. The best of them come in impassioned, self-contained "visionettes" that must be seamlessly woven together. We are agreed that MIT is uniquely positioned to take the lead in redefining a liberal education for a technological age. But that means we have to be so far out front that the path is no longer obvious. We will discuss at length, even argue about, the appropriate turns to take. After some length of time, our ideas will begin to converge.

These are not just local issues. M.I.T. has a special responsibility as the premier institution of technical and scientific higher learning and as an institution committed to societal service since its founding.

We believe that it is vital to the future of technical and scientific education and to the value of that education in resolving major national and world problems that we confront the difficult task of assessing and reweighting the role and value of the core general education component—called the General Institute Requirements—and of the departmental major component—which is the specialization component.

It is equally important that M.I.T take the lead in establishing a new relationship in the core general education component between the humanities, social sciences (including management), and the arts (HASS) on the one hand, and the sciences, mathematics, and technology on the other.

These efforts are beginning with individual faculty, and the initial organization is in the separate schools. We are working toward broad consensus and system-wide change.

The genesis of this large assessment and reformulation is in the School of Engineering's concern for the continued appropriateness of it's undergraduate education for the 21st century. Change is also needed to fulfill the aspirations of the School of Humanities and Social Science to contribute more effectively to M.I.T.'s mainstream educational character and uniqueness as a university "centered on science, society, and the arts."

Such concerns, however, go beyond the parochial boundaries of one or another school. M.I.T. graduates—irrespective of school or speciality—find themselves in positions of influence. The shared destiny of our students means that all areas of the Institute share a concern for the general education core of the undergraduate academic program—both its contribution to departmental degree programs and its stand-alone value in the personal, intellectual, and professional lives of graduates.

From my perspective, it is the undergraduate core program that provides the centripetal force that holds the M.I.T. faculty together and is the ethos of our common meeting ground.

At this early stage in undergraduate reassessment, I want to have many ideas on the table. Later we can be fussy about

which ideas to develop and which to throw out. Alumnae and alumni will be valuable sounding boards as we proceed.

From the arguments, ideas, and proposals that emerge from the many reports, from the spirited community-wide debate and counterproposals—including an impressive effort by the undergraduate students themselves—is emerging the concept of a special breed of core general education that is M.I.T.'s own in definition and purpose.

We hold no brief for a unique curricular solution that will meet all our objectives. Despite the seemingly heated debate over specific proposals or ideas, no one on campus seriously believes that there is just one correct curricular path to serve the needs of all students for the foreseeable future.

The power and significance is in the debate itself, for here is where perspectives, attitudes, and culture are shifted. Here is where the seeds are planted. In this way, our journey is only begun, and travelers should not mistake the way stations for the destination. □

We have to be so far out front that the path is no longer obvious.

Seeking Educational Synergy

BY PAUL E. GRAY, '54
PRESIDENT

The Institute is in the process of the most extensive review of its undergraduate education in 25 years. We are mindful of cautions against fixing something that doesn't need it, but we want to be sure that the undergraduate program is in good shape to meet the challenges and the opportunities of the years ahead.

The world has changed a lot in the last 25 years and will continue to change rapidly; the demands being placed on science-based education are not what they used to be. Many faculty members believe that the academic program is not broad enough for our students. It is appropriate to take another look.

I did not speak at the forum on undergraduate review in May, but I wanted to add my thoughts, however brief, to those reported in this issue of *Technology Review*. I think it is important that we on campus communicate with alumni and alumnae. It is important that alumni and alumnae understand and support this review process—and it is a process, not a fait accompli—and that they share with those of us on campus the insights gained from years of professional and life experience that can help guide our deliberations.

The issue today is not exposure to a greater range of study, but rather the development of a true educational partnership among the scientific, technological, social, and humanistic disciplines.

The greatest professional challenges our students face will not be purely technical. Rather, they will be interwoven with economic, social, and ethical considerations. To act responsibly and professionally, our graduates must have not only the ability but the inclination to view problems, their possible solutions, and their consequences in a manner that draws on and ties together various domains of knowledge.

Much of the ongoing activity of which you will read in these pages and in many future issues of *Tech Review* has the goal of introducing students to a wide range of approaches to knowledge and encouraging them to make connections and analogies across a wide range of disciplines.

This educational synergy that we seek cannot be addressed piece-meal by individual faculty members in separate disciplines. That we have made progress to date in having the issues defined and even some new initiatives in the works is because we have been able to involve so many schools,

so many departments, so many individuals. Credit is due to efforts of Dean for Undergraduate Education Margaret L.A.MacVicar,'65, and the academic deans for spear-heading this massive, cooperative, faculty-based venture.

The progress achieved in developing new core education requirements in the humanities, arts, and social sciences (HASS) and the enthusiasm for the establishment of a minor in these areas is a solid and promising beginning.

We now face a range of related issues:

☐ We must expand our students' creative and design capabilities. Little is known about the creative process and the forces of imagination, but considerable evidence suggests that truly creative scientists and engineers have strong parallel interests in the arts and humanities.

☐ Undergraduate engineering education, at M.I.T. and elsewhere, is generally thought to be overconstrained. It may be time to recognize that professional preparation in engineering should include formal educational and learning experiences beyond the four undergraduate years.

☐ There exists in the M.I.T. community a widely shared sense that the quality of the undergraduate experience suffers from the intensity and pace of our programs. This intensity has consequences for both the creativity our students can develop and exhibit and for the quality of community life.

☐ We need to look again at the current structure of the undergraduate program and at the long-standing tradition of allowing students complete freedom in choosing which and how many courses they will take. We are proud of our "overachievers," but we must consider the sacrifices they may make along the way.

☐ There is growing agreement that requirements in the sciences should be enhanced to ensure that M.I.T. students develop a stronger base for scientific knowledge, including the life sciences.

M.I.T. has a responsibility to provide more than career preparation; we must provide preparation for lives of independent learning and intellectual self-renewal. ☐

Revamping the Groundwork for Lifetime Learning

BY JOHN DEUTCH, '61
PROVOST

Let me begin by saying that the undergraduate education offered at M.I.T. has been under review for some two years, and I for one very much welcome this effort. I think that periodic reappraisal is always a good idea, but particularly now, when it is necessary for this institution to rebalance its attention between the interests of research and graduate education and the needs of undergraduates.

A great deal has been accomplished towards that end already. We now have a governance system in place in the provost's office and in the faculty which allows us to define our priorities and bring about change. We have an associate provost for educational programs, Jay Keyser. And we have for the first time in several years a dean for undergraduate education, Margaret MacVicar.

The faculty has reorganized itself so that one of its most important committees, the Committee on the Undergraduate Program, addresses this question directly. The School of Engineering has had a commission considering the school's education program, and both the School of Science and the School of Humanities and Social Science have had a number of committees looking into aspects of this issue.

What is our objective in this enterprise? To provide the individual student with an appreciation for learning and with attitudes that assure a lifetime of professional or technical competence, social contribution, and individual fulfillment.

There are two important points related to that goal: the first is that this community must convey a spirit of tolerance for the views of others, a capacity to permit a diversity of backgrounds and attitudes. And the second point is that M.I.T. must make it clear that it expects education to continue after graduation; every degree earned at M.I.T. should motivate and prepare the holder for a lifetime of learning.

I see three major variables that will determine our success in achieving these goals. First and foremost, I would point to the quality of the students we admit. Our greatness, our success, the flexibility that we have in a very real sense depend upon the students. The institution draws on what is infused in their minds before they arrive—their attitudes, their ambitions, and their creative forces—and how they relate to each other and the faculty while they are here.

That means that part of this consideration of undergraduate education is a very careful attention to the admissions policies of the Institute and what changes can be made over time. It is important to remember that M.I.T. is always competing with other leading universities for the most outstanding students.

The second variable is the quality of student life at this institution. How do students live? What is the shape of their intellectual life over four years as undergraduates? Enriching their experience means attention to the living group environment, to athletics, to extracurricular activities, to social life. It means attention to how they interact with the faculty and with other people on the M.I.T. staff.

The third variable is the academic program. Important as it is, it is only one of three, and in my judgment, it is third in impact. The academic program consists principally of the curriculum (the type and content of the subjects a student studies), the interaction between students and faculty, and educational methodology (lectures, laboratory subjects, help sessions on closed-circuit television, senior theses, and the like).

When we refer to undergraduate change, we are really examining all three elements: the capabilities of the students, the way they live in this academic community, and the academic program we present.

Why is it that a reevaluation of our undergraduate education seems particularly important at this time? I think that what is motivating many members of the faculty is a sharper understanding that there are new requirements for successful application of science and technology in our society.

The old paradigm about how science and technology operated in this country, or indeed in the Western world, consisted of scientists and engineers developing technological ideas and putting them on a menu for society to exploit. And others—bankers, what have you—decide which one of these ideas will make it in the marketplace and implement it.

I believe that there is considerable evidence that this classical paradigm of science and society no longer operates. Let me mention some areas in which problems have come up: nuclear power, synthetic fuels, hazardous waste disposal, manufacturing, space launchers, urban services. In all of these areas, technical solutions combined with market forces are insufficient to guarantee community well-being.

I believe that there is a sense in society at large and certainly on the M.I.T. faculty that technologists and engineers must be much better prepared to exercise leadership on a full range of issues if technology is to be applied in the public interest. Scientists and engineers should be better guardians of the environment and the workplace; they should be more important participants in the decision-making process in this country.

In my judgment, M.I.T. is offering an education that is too narrow in some respects—certainly not all—for tomorrow's world. It is essential that we broaden the experience of many of our students in the directions of science, social science, humanities, the arts, and management. There must be a fundamental rebalancing of emphasis in an M.I.T. education—somewhat less emphasis on principles, analysis, and research; more attention to integration, design, synthesis, and implementation.

We should never fail to allow a separate pathway for the individual scholar.

I am convinced that we cannot keep piling requirement upon requirement; if we create a new one, we have to drop something.

This array of needs for the future presents a critical problem for M.I.T., best paraphrased by Dean of Engineering Gerald L. Wilson, '61: "So little time, so much to do." How can we best allocate a student's time between the increasing demands for professional education and the demands for a general education that offers a broader range of thought?

In assessing the burden on undergraduates, we can see that simply adding hours of class time would prevent attention to the quality of student life, the time that a student has for contemplation, for imagination, for putting his or her own head together and interacting with others.

We have a terrific tension here, a tension that is understandable. It should be recognized and dealt with straightforwardly. What we face as a faculty is the need to reach a consensus on what we want to do. And the consensus must not merely be the common denominator; it must be a consensus that will *excite* both the students and the faculty at the Institute. Neither will the consensus represent a single vision; we should never fail to allow a separate pathway for the individual scholar.

What are the directions suggested by this line of inquiry? We are moving to more classroom hours devoted to social science and the liberal arts. To a class of admitted undergraduates that share a greater interest in the liberal arts and social sciences for their own sake. To a situation that places a higher premium on self-education. We are moving towards a program that permits the undergraduate to have more experience working in a team atmosphere, to work on integrative projects rather than analytic projects.

Further, we should be working on mechanisms that will improve the communication skills, both written and oral, of our students. A major effort is going into developing new subjects, referred to as context subjects, that will give students an understanding and appreciation of how science and technology must fit into society. And most importantly, we are looking for more effective mechanisms for bringing undergraduate students into closer interactions with individual faculty members.

I was struck when I first read the eight objectives for an undergraduate education developed by the School of Engineering (*See page MIT 23.*), because I believe they are a startling departure from the caricatured image of engineering education held by many people. These goals reflect a very great sensitivity to the need to produce an engineer who has more windows into the intellectual world.

If the goals are to be reached, the School of Humanitites and Social Science will have to play a much more integral part in the education of engineering students than it has in the past—very much the role that the School of Science, for example, plays in providing the scientific principles that underlie engineering.

It is within this context that the faculty dealt this past spring with the first two proposals coming out of the undergraduate academic review process: one is the creation of an undergraduate minor in the humanities, arts, and social sciences (HASS), and the second is refining of the HASS distribution requirement—moves that I strongly support.

I believe that the HASS distribution requirement directs our students to stop at several different points around the intellectual map and see what is there. Specifying five broad areas in HASS over which students must enroll in three subjects is a good way to assure that they sample widely the rich world of liberal and humanistic thought. It is very important that the subjects on the distribution list will now have to pass muster in regard to their breadth of presentation with the dean of humanities and social science and her advisors. Breadth will also be encouraged by the practice of thoughtfully limiting the number of subjects classified as distribution subjects.

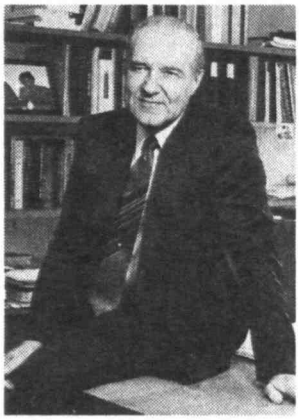
The several months of campus discussion on the minor and the change in the humanities and social science distribution requirement did improve the proposals. They also aroused student and faculty interest in the issues and gave the humanities and social science faculty an opportunity to offer fundamental intellectual leadership in the first stages of undergraduate reassessment.

The larger part of the changes to under-

graduate education remains ahead. There are still serious questions about the way mathematics, physics, chemistry, and biology are taught for non-majors. And there are questions about the engineering curriculum, including the difficult issue of balance between breadth of exposure and professional depth. □

Is Nothing Sacred? Rethinking the Core Requirements

BY GENE M. BROWN
DEAN OF SCIENCE



As alumni are well aware, the School of Science is given the responsibility of educating all the first-year students, regardless of the school in which they later choose to major. All undergraduate students are required to take the core subjects in science and mathematics.

To refresh what may be vivid memories for many alumni: the core subjects are one year of calculus (presently 18.01 and 18.02), one year of physics (8.01 and 8.02), and one term of chemistry. The chemistry requirement can currently be satisfied by taking either 5.11, taught in the Department of Chemistry, or 3.091, taught in the Department of Materials Science and Engineering.

A more general treatment of introductory chemistry is offered in 5.11, so students planning to major in science or chemical engineering take this subject; 3.091 focuses primarily on solid-state chemistry and is considered more appropriate for engineering students.

These subjects are presented to an M.I.T. freshman class that is more heterogeneous than most people realize. Some first-year students arrive having had the equivalent of 18.01, some have even covered the material in 18.02. In fact, about half of the first-year students place out of 18.01 and go on to take 18.02 or other upper level subjects in mathematics. The rest of the class has little or no experience in calculus and definitely needs to enroll in 18.01.

That means that the faculty who teach the physics requirement are faced with the prospect of teaching anywhere from 900 to 1000 freshmen, many of whom have already had all the mathematics they need to understand first-year physics, many of whom have not. (Few students place out of 8.01.)

There is preliminary evidence, which we intend to test further, that students who are taking 18.02 concurrently with 8.01 do somewhat better than those students who are taking 18.01 and 8.01 together. If you actually consider the mathematics required for a complete understanding of physics, it's not hard to imagine that the students who have completed 18.01 are in fact better prepared. If that's true, it is a serious issue, and the School of Science has been wrestling with it for more than a year.

The straightforward response would be to make 18.01 a prerequisite for 8.01. That would mean that half the freshmen would put off enrolling in 8.01 until the spring term and enroll in 8.02 the following fall. Does that strategy create new difficulties? Probably, but I think they could be managed. For example, if core subjects are not completed in the first year, pass/fail might have to be extended to cover 8.02 whenever it is taken.

Another mechanism to ensure that students are prepared for the physics requirement might be to generate two versions of 8.01. That possibility is under serious discussion, although it means that the Department of Physics would have to find two faculty members to lecture for 8.01.

The least radical strategy is to structure much better coordination between 18.01 and 8.01, to ensure that certain mathematics concepts are covered in 18.01 before they are taken up in 8.01. This third option was in fact operating during 1986-87; there was much more communication between

Relatively few students study any of the humanities disciplines out of a fundamental intellectual interest.

instructors in freshman physics and mathematics than we have had in the past. Such communication turned out to be quite helpful in identifying the problem areas and suggesting some solutions, but it is not the whole answer.

Another area of the science curriculum under review is the chemistry requirement. It would make sense to develop a core chemistry requirement to serve all degree programs—meld 5.11 and 3.091 into one subject—and the School of Science is at work on it.

Perhaps the most dramatic change being considered by the School of Science is the creation of a subject in the life sciences that would be appropriate for all M.I.T. undergraduates. The molecular biological revolution has come to have a major impact on everyone's life. It is increasingly important for educated people to have at least enough background in the life sciences to enable them to judge the validity of what appears in the popular press—much of which is quite simply wrong.

It would be easy enough to create such an introduction to the life sciences, but I'm not ready to suggest that it become a new requirement. I am convinced that we cannot keep piling requirement upon requirement onto our students. They have enough requirements already; if we create a new one, we would have to drop something somewhere else.

But do we have to change the core subjects? Couldn't we just take remedial actions to make them more effective elements in the undergraduate education? Well, we could, and we already are doing that. The most obviously vital area is the quality of teaching: we must be serious about making sure the subjects and the lecturers are a good match in the core subjects.

We also see a need for better communications between lecturers and recitation instructors and for better coordination between the faculty in physics, mathematics, and chemistry who teach the core subjects, to ensure that important topics don't fall between the cracks. We've made some progress in each of these areas, and expect to accelerate the process of review and change in the coming year.

I'd like to turn now to the science distribution issue, which the Science Education Committee has discussed at great length in the past year. Currently, each student must take three science distribution subjects. No more than one of these subjects is to be in the student's major department and no more than two can also be used to satisfy a student's departmental program.

What has happened is that most, if not all, of the M.I.T. departments have "captured" two of the three science distribution subjects for the departmental required program. That situation subverts the purpose of the science distribution requirement, which is to broaden or deepen education in the basic sciences.

The School of Science Education Committee has recommended that we accept reality—that only one subject is being used by each student to broaden his or her exposure to science—and reduce the science distribution requirement to one subject. That subject, the committee stated, "should exemplify the way science or math is done by dealing with a broad subject, by discussing unsolved problems, and by treating both successful and unsuccessful attempts to solve the problems."

The committee goes on to say that the subjects on the science distribution list should be reviewed periodically by the dean of science and a special advisory committee. Let me mention a few examples that might be considered for a new science distribution list: in physics, an introduction to relativity or an introduction to quantum physics; in mathematics, probability and statistics, mathematical modeling, foundations of analysis, and key discoveries in math; and in chemistry, introduction to quantum chemistry or a class in the determination of molecular structure.

And finally, I believe that careful attention will have to be given to the laboratory requirement. The laboratory requirement was designed to be a project laboratory. Of the 41 subjects that presently satisfy the laboratory requirement, very few if any actually fulfill the spirit of the original requirement. I think the original intent was sound, and we should return to it. This issue will require the attention of an Institute committee in the near future. □

School on the Front Line

BY ANN F. FRIEDLAENDER, Ph.D.'64
DEAN OF HUMANITIES AND SOCIAL SCIENCE

As the review of undergraduate education continues, and as the importance of the humanities distribution requirement and the humanities minor grows, I believe that there are two distinct but related issues that must be addressed by the Institute community: one is the role of the humanities, arts, and social sciences (HASS) in M.I.T.'s undergraduate education; and the other is the role of the Department of Humanities at M.I.T.

In assessing the role of the HASS requirements in M.I.T.'s undergraduate education, it is important to realize that they have three distinct but related goals. The first is to provide sufficient exposure to the humanities, arts, and social sciences to ensure that M.I.T. undergraduates have an understanding of the social, cultural, and intellectual forces that have shaped present society and to support their lifelong appreciation and learning in these areas. The second is to give students an understanding of the social and ethical implications of the reciprocal or symbiotic relationships between science, technology, and society. And the third is to provide students with an exposure to many analytical approaches and modes of knowledge that will enhance their ability to frame problems in many contexts, to synthesize and integrate different views and perspectives, and to expand their creative and design abilities. Although this last goal is less well articulated than the others, it may well be the most important.

The revised HASS distribution requirements, in conjunction with the existing concentration requirements, are designed to ensure that students have a broad and deep exposure to the humanities, arts, and social sciences—one that will serve them well in their future lives—and a significant exposure to a broad range of approaches to knowledge.

In addition, the new context subjects are aimed specifically at providing students with an understanding of the social, political, ethical, and economic consequences of science and technology.

The second of the key issues I mentioned, the role of the Department of Humanities per se, is closely connected to the place of humanities in the curriculum at M.I.T. In this connection it is important that the Institute community recognize that the department is in an anomalous situation here, in that it is the only group of faculty that plays an exclusively service role.

In practical terms, this means there are no graduate programs, no graduate students available to the faculty within the humanities department, and few majors. Thus there are relatively few students who study any of the disciplines within the humanities out of a fundamental intellectual interest rather than from a need to meet Institute requirements. Moreover, there are relatively few students who take more humanities and social science subjects than the minimum number required.

Under this set of working conditions, quite frankly, it is difficult to hire and maintain a first-class faculty. Difficult, but not impossible. It is important that M.I.T. not have a disparity between the quality of the faculty in the humanities and in other departments, and indeed, we have not had such a disparity.

But we must ensure that the faculty within the Department of Humanities have an outlet for their professional interest in teaching and have access to a significant number of interested and involved students. The new minor in humanities and social science is expected to appeal to students with a serious interest in dual literacy (science and humanities) and to help increase the number of such students at the Institute.

Further initiatives are under consideration that could attract humanities-oriented students and enrich the teaching environment for humanities faculty: a dual major, perhaps even a special double integrated

The new "Context Subjects" will bring students together with faculty from different disciplines who hold dramatically varied views.

major in humanities and other disciplines; or small graduate programs that capitalize on M.I.T.'s unique character, such as a Ph.D. program in the history and social study of science and technology or a Ph.D. program in American studies. And a final idea that has been on the table for some time: creation of a humanities-based research center, to bring scholars in the humanities together with scholars in other disciplines.

In brief, the humanities disciplines and humanities faculty are an integral and essential part of the Institute and play an important role in the intellectual leadership it provides to the world at large. Thus the curricular initiatives currently under discussion will not only strengthen the role of the humanities disciplines and the humanities faculty within the Institute, but will also strengthen M.I.T.'s educational force and mission. □

The Winds of Change Blow Through M.I.T's Largest School

BY JACK KERREBROCK
ASSOCIATE DEAN OF ENGINEERING

The School of Engineering is deeply committed to providing a broader education for its undergraduates—an education suited for leaders in an increasingly technological society—without, however, any sacrifice of the technical excellence for which M.I.T.'s undergraduate education is justly famous.

That commitment to breadth is embodied in two of the Goals for an Engineering Undergraduate Education, which were developed over a six-month period and published in September last year (*see facing page*). The relevant goals are: first, that engineering undergraduates should have begun to understand the diverse history of human societies as well as their literary, philosophical, and artistic traditions; and second, that these students should have begun to understand and respect the economic, managerial, political, social, and environmental issues surrounding technical developments.

Most important, the school is according to these two goals the same weight, the same priority, as to the more traditional, technical goals for engineering education. We are very serious about that.

To accomplish such a broadening of the undergraduate education, the school has begun to modify its environment to make it more supportive of education in the humanities, arts, and social sciences (HASS).

We consider the recent changes in the humanities distribution requirement and the creation of a minor in HASS to be important steps that will serve our goals. The essential feature of the former is the restructuring of the distribution offerings into five carefully defined groups of subjects that represent the several modes of thinking other than the analytical and quantitative modes associated with engineering and science.

The minor in HASS gives students an opportunity to study some area in depth and to receive recognition for their accomplishment. A second feature of the minor program is that it will significantly increase the number of students within engineering and science who have a declared commitment to humanistic studies, something we judge is badly needed at M.I.T.

Another element of a broader education is improved access to science subjects along the lines under consideration in the School of Science, through a more rational science distribution requirement or through electives more appropriate for engineers. The School of Engineering is prepared to work closely with the School of Science to make those improvements.

The process of undergraduate review, has been underway in our school for almost two years under the aegis of a Commission on Undergraduate Engineering Education. We have already launched a number of initiatives.

One of our first projects was to collaborate with the Undergraduate Association on an enhanced system of subject reviews. The first substantive product of this collaboration was the Fall '86 *Course Evaluation Guide,* which contains evaluations of more than half of all the undergraduate subjects in the School of Engineering. The student role was a leading one; some 100 students worked over the timespan of one semester.

In that evaluation process, more attention was paid than in the past to two particular issues—the quality of education and the workload imposed by each subject on the students, as judged by the students themselves.

The information on engineering subjects that can be found in the *Course Evaluation Guide* has been discussed in some detail in Engineering Council, with the emphasis on "truth in advertising." The workload involved in a subject should match the subject description in the *Bulletin;* but time after time, the students report that in fact much more work is required than the *Bulletin* indicates. It is a problem the school and the departments must address.

The *Course Evaluation Guide* also bolsters efforts in the School of Engineering to focus increased attention on quality of teaching by providing quantitative data for the discussions among faculty.

The second substantive action we've taken is to form a working group on "context subjects." These new subjects will be educational activities of some sort—not necessarily structured lecture, recitation, and homework activities—that bring students together with faculty from different disciplines, who hold dramatically varied viewpoints on some subject or theme, to share their views and to learn from each other. These subjects will be designed to frame issues in science and technology in the broadest human context.

The Interschool Working Group on Context Subjects has some 35 faculty members from the Schools of Engineering, Science, Management, and Humanities and Social Science deliberating on how M.I.T. should construct such educational activities.

From the process of developing context subjects has come a great deal of mutual education among the faculty members as well as concrete proposals, several of which have already been endorsed for trial implementation in this academic year. Each of these proposals involves faculty from more than one school, a relatively simple strategy that we believe will be successful in breaking down the narrowness of disciplinary focus that may have characterized an M.I.T. undergraduate education to date.

(I want to say again that the traditional narrowness of focus in an M.I.T. education was associated with a very high level of professional competence. We intend to broaden the focus while preserving the competence.)

The School of Engineering has also launched a Working Group on the Faculty Instructional Resource Program—a complex way of saying that we intend to help faculty improve their teaching. We want to provide mechanisms for transferring teaching expertise and knowledge from one faculty member to another.

Further, a Working Group on the Teaching of Design was established to respond to the concern that our students aren't given enough opportunities to exercise their talent for design and to be taught the skills of design. We also believe that the undergraduate engineering program lacks opportunities for faculty and students to interact around projects in synthesis as opposed to analysis, and the enhanced teaching of design is expected to address the second problem as well.

I'd like to close by saying that we are not at the end of a period of change, but only at the beginning. This will be a continuing process of review and renewal, not one in which we enact a set of legislation and then live by it hereafter. The essence of the process that has been going on for the past two years is one of very intensive interaction between the faculties of the different schools. I think the major gains are likely to come from that interaction. □

Goals for Undergraduate Engineering Education

☐ *Have obtained a firm foundation in the sciences basic to their technical field.*

☐ *Have begun to acquire a working knowledge of current technology in their areas of interest.*

☐ *Have begun to understand the diverse nature and history of human societies, as well as their literary, philosophical, and artistic traditions.*

☐ *Have acquired the skills and motivation for continued self-education.*

☐ *Have had an opportunity to exercise ingenuity and inventiveness on a research project.*

☐ *Have had an opportunity for engineering synthesis on a design project.*

☐ *Have developed oral and written communications skills.*

☐ *Have begun to understand and respect the economic, managerial, political, social, and environmental issues surrounding technical development.*

Contemplation, Consequences, and Community

BY SAMUEL JAY KEYSER
ASSOCIATE PROVOST FOR EDUCATIONAL POLICY AND PROGRAMS

Whenever I have the opportunity to stand behind a podium—as I did last spring at an MIT Forum on Curriculum Change—I feel an overpowering urge to preach. I usually give in to my urges and that occasion was no exception. My sermon was in three parts: Contemplation, Consequences, and Community.

For contemplation, my text was drawn from Alexander Pope's *Essay on Criticism.* Probably most of you are familiar with the first line:
A little learning is a dangerous thing.

The more complete quotation is:

A little learning is a dangerous thing;
Drink deep, or taste not the Pierian spring:
There shallow draughts intoxicate the brain,
And drinking largely sobers us again.
Fired at first sight with what the Muse imparts,
In fearless youth we tempt the heights of Arts,
While from the bounded level of our mind
Short views we take, nor see the lengths behind:
But more advanc'd, behold with strange surprise
New distant scenes of endless science rise.

Now Piera is a Greek island where the Muses were worshipped. So Pope's Pierian Spring is the spring of learning, and Pope is reminding us that when it comes to learning, less is more. It is a message that contravenes the prevailing spirit at M.I.T., which encourages students to "do as much as you possibly can until your back breaks, then do more."

For example, under the freshman-year pass/fail system, there is tremendous peer pressure for studentsto take as many credit units as they can. The upperclassmen who advise freshmen say, "Well, you should take four subjects. I took seven, but I can get along with no sleep; you should take four." And of course, the freshmen take seven.

I know there is more than one thoughtful way to view this issue, but I'm going to come down on the side of limiting the number of subjects a student can take in the freshman year to four. I think, following Pope's advice, that it is much better to study a few things at leisure and at length than a lot of things on the run and on the surface.

A student friend of mine who is a wonderful piano player came to see me last year. He was taking a subject in one of M.I.T.'s larger departments, and he was really upset. "You know, this is terrible. I was given eight problems in a problem set this week. I know these problems, I don't need to go through all eight. It was worse than punishment because it kept me away from the piano. No curriculum should be so merciless that there isn't time to practice." The next week he came in and said, "This week we had only three problems. Not only was I able to do them and practice my piano, but I could do them in three different ways, so that I could explore the problems." Providing a curriculum that enables students to explore at leisure is something that we ought to do.

Now I come to consequences. For those of you who have not read *The Book of Revelations* recently, I recommend that you do. *Revelations,* from which my text for consequences is taken, is one of the most frightening texts in the Bible. In the eighth chapter, the Lamb of God opens the seventh seal and there follows a half hour of silence. (I would like to know why there was a half hour of silence. If anybody knows, I wish you would let me know. We could probably use it here.) At any rate, after the space of half an hour, seven angels appear and each is given a trumpet. Each angel sounds the

trumpet and a vision of a devastation visited upon the earth is described. The vision of the third angel is particularly interesting. It is described in the tenth and eleventh verses:

> *10 And the third angel sounded, and there fell a great star from heaven, burning as it were a lamp, and it fell upon the third part of the rivers, and upon the fountains of water;*
>
> *11 And the name of the star is called Wormwood; and the third part of the waters became wormwood; and many men died of the waters, because they were made bitter.*

It is a remarkable coincidence that the Ukranian word for wormwood is *Chernobyl*. It comes from the root *chern*, meaning "black," and *byl'*, meaning "stalk". Taken together, the compound *cherno + byl'* "black" + "stalk" refers to *artemisia absinthium*, a plant that is used to make absinthe bitter.

That remarkable coincidence leads me to the second point in my sermon: I am dreadfully worried that technology is out of control, and that our century has allowed this to happen at a tremendous rate. If we as a faculty believe this message, then I think we need to teach it. Our students will not take it seriously unless the faculty does. The faculty has to be willing to find a place to address this issue in the curriculum—or perhaps outside it. It does not really matter where, but our faculty and students must worry about the consequences of the technology that we have but do not master.

My third topic is community, and my text is from Duke Ellington:

It don't mean a thing if it ain't got that swing.

The problem here is: M.I.T. is not fun. The dearth of fun at M.I.T. is often blamed on the rigor of the place, but I am not really sure that M.I.T. is too hard. Lack of fun is just a symptom, and I believe that the problem arises because something is out of whack with respect to community—the way we live together here.

For one thing, the way we do residence selection compartmentalizes our students from one another and from M.I.T. itself. R/O week essentially bonds students to their living groups and not to the community or the Institute. I hasten to add that not everyone sees this as a problem. I expressed my concern at a meeting of the Interfraternity Council last spring and was surprised to find that my comments actually offended some of the students there.

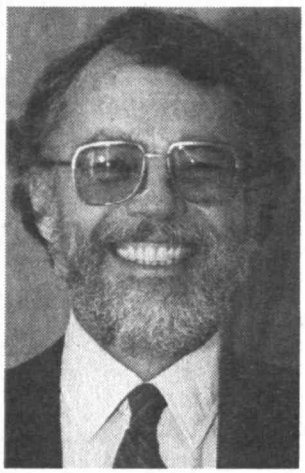
Through that kind of experience, and through being a housemaster at Senior House, I have learned that the living groups that have evolved at M.I.T. play a very important role in the lives of our students. They form a support system that really belongs to what Ben Snyder has called "the hidden curriculum" in his book of the same name. Living groups have become social mechanisms used by students to get through M.I.T. That is the upside of the situation. The downside is that the living units tend not to encourage members to move outside their groups to the larger community. I think that is a problem.

A second problem I see is that faculty members are not involved in student life. That is perfectly understandable. It is not easy being a faculty member at M.I.T. and maintaining a relationship to one's research, one's colleagues and, most importantly, one's family. Students sometimes get short shrift. Can we change that?

I know it would be valuable to have faculty housing closer to M.I.T., but that is no longer practical. There is a plan to place faculty fellows in all the houses, and that will help. But even if we manage to involve a hundred faculty members in that program, we will still only have reached 10 percent of the faculty. We will have to do more than that to fill the need for faculty involvement in the life of the community.

So that is it. From a perspective formed over the past ten years as a member of the M.I.T. faculty, six years as a housemaster, and the last two years as associate provost for educational policy and programs, I have come to believe that we, as a faculty, should try to provide more time for contemplation for our students—more time to do less, try to inculcate a greater concern for the consequences of our technology and, finally, try to find ways in which we can all function as part of the same community and have fun doing it. Amen. □

Something is out of whack with respect to community—the way we live together here.



Curriculum Is Only a Piece of the Undergraduate Experience

BY DAVID S. WILEY, '61
REGISTRAR AND FORMER HEAD OF THE UNDERGRADUATE ACADEMIC SUPPORT OFFICE

My task is to give an overview of some of the issues and the agenda in the area of undergraduate academic support—that is, the resources outside the classroom that M.I.T. provides to help students complete their degree programs and realize their own intellectual goals.

I'd like to start with the academic advising system and the related issue of student/faculty interaction. One of our major goals continues to be strengthening the freshman advising system. Advisors have a range of responsibilities aimed at influencing the pace and content of students' programs. To be effective, advisors must be accessible, really get to know students, and have a broad knowledge of both M.I.T. and the undergraduate program.

If their advisors lack one or more of these qualities, freshmen tend to turn to other students for advice about important academic decisions. Similar problems must be addressed in advising upperclass students and in helping students plan their subjects in the humanities, arts, and social sciences (HASS).

Now students have much to offer each other, which is why we set up the associate advisor system to provide freshmen with regular help from upperclass students trained for that role. But students need regular access to advisors with greater life and Institute experience than their peers, and it is M.I.T.'s job to design and provide the structure, support, and recognition that will enable advisors to be most helpful.

M.I.T. is also determined to find natural ways to strengthen the intellectual and social interaction between faculty and students. For example, the Freshmen Advisor Seminars, now in their second year, are led by distinguished faculty members for their freshman advisees. The seminars appear to be particularly effective, both in terms of the close relationships that develop and the level of intellectual discussions that arise.

The pilot seminars were so successful that their number has been quadrupled to 33 this year. Now more than 25 percent of the Class of 1991 is able to participate.

Furthermore, we have been able to build in a little more faculty involvement in the living groups by organizing groups of freshman advisors who have all their advisees and associate advisors residing in the same living unit. The program contributed to a greater sense of community in Baker House and in 500 Memorial Drive last year, and continues this year.

The Institute's commitment to improving this aspect of undergraduate education was underscored last year by Provost John Deutch, '61, when he requested that all department heads develop specific plans whereby faculty contributions in such academic areas as advising and seminars are appropriately recognized.

The Office of the Dean for Student Affairs also plans to train associate advisors to take on more substantive roles in assisting freshmen in areas like study and time management skills, choice of major, and choosing HASS subjects.

A second area I want to talk about is the need to improve evaluation information and support for students. We want to improve our ability to identify and assist as early as possible freshmen who may be heading for academic difficulty. By maintaining close contact with faculty teaching core subjects last year, the Undergraduate Academic Support Office (UASO) was able to help advisors give appropriate support and guidance to freshmen in a timely way.

We hope that the instructors for the core science subjects will find additional meth-

ods of identifying before mid-term those students experiencing serious difficulties and will provide special support programs to help them finish satisfactorily by the end of the semester. The faculty should also consider allowing term work to extend into the Independent Activities Period (IAP) in January, if that's what it takes for some students to be successful in the core subjects.

M.I.T. is also taking another look at pass/fail, although we are intensely aware that it is a complex and particularly sensitive area. One of the principal objectives of the first year is to have students adjust emotionally and intellectually to the demands of M.I.T. The question being addressed is whether pass/fail, particularly in the spring term, strengthens or undermines efforts to achieve that goal.

In the July issue of *Technology Review, (pages MIT 10-13)* Director of Admissions Michael Behnke discussed the policies and strategies behind the selection of this year's freshman class. The success of the revised admissions process in bringing a more diverse group of students to M.I.T. means that now the Institute must concern itself with fulfilling a more diverse set of educational aspirations. A monolithic science core curriculum is not likely to be satisfying for every student.

A meaningful option, particularly for students not intending to major in science or engineering, might be to defer taking 8.01 until sometime after their first term. We also need to explore alternatives to having problem sets as the nearly exclusive mode of learning in the technical subjects at M.I.T.

I know it's been said before, but it is really important to address the pace and pressure at M.I.T. In the UASO, we routinely see the adverse effects that pressure has on the self-esteem and confidence of many of our students. Moreover, students don't have time for reflection, and we should be seriously considering reducing the number of degree requirements to allow them that time.

Another major objective of the undergraduate review process is development of a more appropriate introduction of new students to M.I.T. Currently, Residence/Orientation (R/O) Week focuses largely on housing selection. More attention should be given to orienting students to the diversity of intellectual styles and programs at M.I.T. and to encouraging freshmen to think more about what they want from their M.I.T. experience.

The Independent Activities Period should be strengthened. Efforts were begun in 1986-87 to achieve richer student-faculty intellectual encounters, more Institute-wide community-building activities, and greater emphasis on meeting the needs and interests of freshmen. These efforts will continue.

The process by which students explore possible choices of major needs attention. One move in that direction was a banquet last year that brought faculty and alumni to talk about their varied career paths with freshmen. The Freshman Council and the Alumni Association took part in planning the event, and we think that was an effective working model.

M.I.T. also needs to focus on the role of living groups and student activities in providing many of the skills and experiences our graduates should have. The entire community should recognize that the total undergraduate experience, not just what happens in the classroom, can contribute to the goals of educational change.

The final and perhaps most overarching goal I want to talk about is the need to reorient our thinking as students, advisors, faculty, and alumni: we all must believe that every M.I.T. student is a valuable resource and can be successful at the Institute. Given the caliber of students admitted, no one needs to fail here. M.I.T.'s vision for itself must be to become a more student-centered university in both our academic programs and support services and to help each student fully achieve everything that she or he is capable of achieving. □

We routinely see the impact that pace and pressure have on the self-esteem and confidence of our students.

CLASS NOTES

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It is our sad duty to report on three classmates who have passed away. Long overdue is word we thought had been included earlier—namely, **George D. Kittredge's** death at his home in Laguna Hills, Calif., last October. Few classmates will recall that his father, George W. Kittredge, was not only an alumnus (class of 1877) but was also a member of the M.I.T. corporation from 1907-1912. And even fewer would realize that Denman Kittredge McNear, '48, our George Kittredge's nephew, carries on the family tradition. Denny was the 88th president of the Alumni Association, and he, too, currently serves on the M.I.T. Corporation.

Another sad note is the passing after a brief illness of **Jim Flaherty**, who attended all our annual and five-year reunions. Jim leaves behind many monuments to his professional skill as a church architect. They include churches in Westwood, Waltham, Duxbury, Milton, the Kennedy Center in Brighton, and the Grace Ryder School in Marshfield, where he summered many years. He was an accomplished pianist, but classmates will better remember him for his lovely watercolors. Clearly one of his finest is a scene of Calder's "Great Sail" on the M.I.T. campus which belongs to **Stan Dunning,** is currently loaned to our class honorary members, Phyl and **Don Severance,** and will be the property of the M.I.T. Museum.

We also have word of **Warren Tapley's** passing just a couple weeks short of his 94th birthday. As his daughter wrote: "still macho—still M.I.T.—still worth it." Incidently, Course XV, business and engineering management, graduated its first class in 1917, and Warren was one of that first group.

We close on the pleasant note that **Ossie Holt** writes he is active at his "adopted" home in California and is still active—playing the piano twice a week at the convalescent hospital associated with the retirement home and at various birthday celebrations and after events.—*ed.*

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There is a dearth of news this time of year. Please drop us a line, a postcard, a letter about yourself—your classmates would like to know of your whereabouts and your activities.

We're sorry to report that **Lawrence J. Allen** of Glendale, Calif., died June 12, 1987. We have no further details at this time.—**Max Seltzer,** Secretary, 865 Central Ave., Needham, MA 02192; **Leonard Levine,** Assistant Secretary, 519 Washington St., Apt. 15, Brookline, MA 02146

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Aubrey Ames wrote an interesting letter. He is now in his 92nd year. Except for eyesight and a heart condition, he is doing quite well in his San Francisco home. He and his wife have given up their extensive travel, and he cannot be as active as he formerly was in the local M.I.T. Alumni Association. It is a pleasure to hear from Aubrey.

Have endeavored to talk to a classmate or two each month, but it is surprising how few answer—not a bad sign though. Recently I talked with Mr. and Mrs. **Don Way** of Westfield, N.J. All are doing well, asking about their classmates and their ages.

The Alumni Office sent us notices of the deaths of **Elizabeth Coit,** age 94, and of **John L. Riegel,** age 89. While I did not share classes with either of these two classmates, I find many who did so, and they are anxious to hear something about them. Elizabeth Coit was an architect and worked mostly in New York, but at the time of her death her address was Bar Harbor, Maine. She was a graduate of Radcliff, Boston School of Fine Arts, and of course M.I.T., where she graduated an architect. She was first employed by the firm of Grosvenor and Atterbury in New York City. In 1929, she established her own business. She was most active in the matter of low-income housing in the United States and was appointed to the Federal Housing Authority. In 1947, she joined the firm of Mayer-Whittlessey in New York and later accepted the post of principal project director of the New York Housing Authority. She is survived by her brother Robert of Rockport and six nieces and nephews. We all can stand proud of this classmate.

My notes on the death of our distinguished classmate **John L. Reigel,** who died on May 1, 1987, will appear in the next issue of the *Review* after I get some additional information. Meantime, my best to all of you.—**W. O. Langille,** Secretary, P.O. Box 144, Gladstone, NJ 07934, (201) 234-0690

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It is my sad duty to report the death of three of our prominent classmates. **Phil Young** of Greensboro, N.C., died on May 1, 1987, leaving a generous contribution to the M.I.T. libraries. He was a popular and loyal member of the class. . . . **Ken Newhall** of 25 Rock Ave., Swampscott, Mass., died April, 11, 1987. He is survived by his son William. He was a faithful attendant at several reunions.

Ben Groisser died on February 20, 1987, and is survived by his son, Leon, four grandchildren, and a great-grandson. He was a founder of the Iron Works construction firm, Grossier and Shlager (also a classmate), one of the major steel fabricating companies of New England. He lived in Brookline, and his latest address was 75 Norumbega Rd., Weston, Mass.

Visits from **Al Burke** and telephone visits from **Buzz Burroughs** and **Frank Maconi** have helped to round out the month for your class secretary. I am happy to report them in good health and spirits. Incidentally, Frank's name was not included in the notes that listed many of our class. Why, I do not know, for there is no more loyal classmate than Frank. I, hereby, apologize.—**Harold Bugbee,** Secretary, 313 Country Club Heights, Woburn, MA 01801

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In my last class notes, I took **Cac Clarke** and **Sam Lunden** to task for not sending me news. A phone call from Cac within two weeks brought me news, some bad, some good. He followed up with a good letter for which I am grateful. The sad news was that **Munroe Hawes** of Sea Girt, N.J., died on June 20, 1987. Munnie was one of the 4-Hs—**Munroe Hawes, Sumner Hayward, Sanford Hill,** and **Frank Huggins**—who attended classes together in Course X in our undergraduate years. Those classes also included **Bob Felsenthal** and **Herb Kaufmann.** Munroe Hawes was co-owner of Hawes and MacAfee, a real estate and insurance firm in Manasquan since 1927. He was active in town affairs—city council, school board, Kiwanis Club. His wife Alexandria survives him.

Maxine and Cac attended Technology Day and stopped to pick up **Helen St. Laurent** in Manchester, Conn. They attended Tech Night at the Pops, the sherry party given by the *Review,* and events at Kresge. **Don Morse** and **Frank Whelan** attended the Technology Day luncheon. Frank Whelan gave Cac some printed notes on his son, Reverand Joseph P. Whelan, S.J., who has risen high in the ranks of the Jesuits and now resides in Rome.

The Clarkes became great-grandparents on May 27 with the birth of Ian Joseph Shinberger in Virginia, grandson of their daughter Ellie. Cac was recently appointed by the mayor of Brielle as honorary chairman of the Brielle Constitutional Bicentennial Committee. Congratulations! The Clarkes took their tenth annual Caribbean cruise this spring on the Holland American Line and took the opportunity before embarking to talk to Graciela and **Helier Rodriguez** in Tampa.

Another obit this month is that of **Waldo Adams** of Dubuque, Iowa, who died on December 30, 1986. Our sympathy goes out to the widows of these classmates.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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Our 65th Reunion on June 3, 4, 5, and 6 was a success. 23 classmates (13 with wives) assembled with headquarters in McCormick Hall to spend an enjoyable four days of alumni activities and visits with old friends and places. In attendance were Hannah and **Irving Abrams,** Madeline and **Parke Appel, C. Hall Baker,** Madeline and **Lee Carroll, Yardley Chittick,** Marion and **Saul Copellman, Roberts Cummings,** Aline and **Ray Ellis, William Elmer,** Charlotte and **William Freeman, Lawrence Gentleman** and Peg Moore, **William Gray,** Mary and **Oscar Horovitz, Abbott Johnson** and grandson David Douglass, Gerry and **Edward Keane,**

Ruth and **Milton Manshel**, Kate and **Horace McCurdy**, **H. Felton Metcalf**, Muriel and **Theodore Miller**, **Martha Munzer Corkland**, Elizabeth and **Edward O'Connor**, Marjorie Pierce, **Walter Saunders** and **Leland Thomas**.

The reunion activities started Wednesday evening with a fine dinner at the Faculty Club to which were invited present and past holders of 1922 chairs. After dinner and following introductory remarks by class president **Parke Appel**, president Paul Gray, the second occupant of the 1922 professorship, spoke, thanking the class for inaugurating the concept of endowed chairs which has been copied by other classes to the great genefit of the Institute.

Thursday started with breakfast right in McCormick. Then at 11, by bus to Endicott House in Dedham where we had wine and a very good lunch followed by humorous reminiscences by **Martha Munzer** of her days as one of the very few women in Tech in our time. Bus back to McCormick in time for a nap before dinner. Thursday evening followed the well settled plan of dinner for all alumni in the Student Center, buses to Symphony Hall for Pops with John Williams conducting and return to McCormick by eleven. We sat right down in front, so close to the stage that we could see only the front row violinists and now and then be overwhelmed by the extraordinary volume of sound a hundred or so musicians can create when demanded by the maestro.

Friday morning many of us attended the Memorial Service in the M.I.T. Chapel honoring those alumni of all classes who died during the preceding year. This was followed by substantial attendance in Kresge to hear about the Athena Project which is intended to place M.I.T. at the head of teaching through the use of computers. Alumni Day luncheon in the Athletic Center was as always the dull spot. The food, expensive and second rate, preceded remarks by the Alumni Association president and the representatives of the 25, 40 and 50 year classes on the subject of how much money had been collected for the Alumni Fund. Thankfully president Gray in brief comments at the end put the Institute's need for money in good perspective. The best part of the luncheon period was as always the opportunity to see and talk with old friends. The dinner party Friday evening made up for the lunch. It was held in the conference room in the Grier Building. Drinks and hors d'oeuvres set the stage for an excellent meal followed by impromptu talks by a number of classmates including humorous stories and anecdotes of the recent and distant past. The bus had us back at McCormick by nine o'clock.

On Saturday after breakfast in McCormick we went by bus to the Eastern Yacht Club on Marblehead Neck. The bus route was arranged to provide a mini-tour through Boston much to the pleasure of many who were unaware of the great changes that have taken place in the last five years. On arriving at the yacht club we had time for drinks and much good conversation before a satisfactory lunch. Then back to Cambridge in time for a nap before dinner at McCormick at which Professor Sizer was the speaker. This concluded the planned activities. The final farewells were on Sunday after brunch.

A few comments: Horace and Kate McCurdy were our long distance champs, coming from Seattle. Four came from Florida, three from Maine, three from New Hampshire, two from New Jersey, one from Indiana and ten from Massachusetts. The consensus was that our 65th, just ended, would be the last organized reunion. On June 12 I went to reunion at Andover where I was joined by Bill Gray (we were both class of '18). Andover has the pleasant habit of inviting the old guard to attend Reunion Weekend as guests of the school for the full three days of activities.

Recently, I had the opportunity to read the book *Ready All*, the biographical account of George Popcock, the legendary builder of racing shells. In this book are numerous mentions of the strong part **Horace McCurdy** played in support of crew at the University of Washington and at M.I.T. In 1969, the two inductees into the Helms Rowing Hall of Fame were Pocock and Mac. One final note about Mac. Last May 5th at the Westin Hotel in Seattle, Mac along with William M. Allen, former president of Boeing, William E. Boeing, founder of Boeing, Frederick Weyerhaeuser, the deceased lumber magnate and four others of equal prominence were inducted into the Puget Sound Business Hall of Fame. Our congratulations to our able classmate.

Edwin Rosenberg, '47, didn't know that Martha Munzer, '22, was an M.I.T. graduate when she was his high school chemistry teacher in New York City. Now he does—they were glad to see each other last June during his 40th reunion and her 65th. "What a long road there's been from that 'female student' of the 20s to the great-grandmotherhood of eight in the 80s!" says Martha Munzer. "And how much of the adventure I owe to the doors that were opened because I was a graduate of M.I.T. How does one say thanks?"

Since the reunion, I have had another letter from Marian and **Roy Stone** expressing appreciation of the inquiries about Roy's inability to attend. Poor health was the culprit.

I regret having to report the death of several of our classmates: **Arthur M. Bell** of Stanford, Ky. died October 26, 1986; **Harold R. Boyer** of Grosse Pointe, Mich. died February 14, 1987. He is survived by his widow, Frances; **Chauncey E. Eaton** of Westmont, Ill. died October 26, 1986; **Ralph E. Hanten** of Watertown, S. Dak. died in June 1984. He is survived by a son, John. Mrs. **Evelyn O. McKnight** of Williamstown, Mass. died April 19, 1987. **Clarence Spofford** of Gardner, Mass. died September 19, 1986. I am sorry that as of now I have no career details of the above deceased classmates. I must here add one more sad note. **Ed Keane** who, as noted above, was at the reunion died two weeks later at his daughter's home in Mercer Island, Washington. Those of us who knew him were thankful to have enjoyed his company one last time. From 1925 to 1941 Ed worked for several private engineering companies and public agencies gaining experience in field engineering, heavy construction and a broad range of civil engineering projects. This led him to Fay, Spofford & Thorndike where from 1941 to 1945 he worked as division engineer in charge of highway design and air fields for subarctic military bases. In 1945 and 1946, he worked on the design of the Boston Airport. Later he was assistant chief engineer of the design force for Alaskan Military Construction, assistant chief engineer of the design office for the Boston Central Artery, and in 1956 he became director and vice president of Fay, Spofford & Thorndike. From 1980 until his retirement in 1986, he was the company's consultant. He was past president of the Boston Society of Civil Engineers and later editor of its journal. He was also past president of the Massachusetts Section of the American Society of Civil Engineers. He is survived by his wife Geraldine D. Berrigan of Cambridge, three daughters, Mary J. Coffey of Chelmsford, Barbara M. Blais of Mercer Island, Wash., and Nancy Kruger of Newtonville; two sons, David of El Granada, Calif., and Paul of Frenchtown, N.J.; a brother, T. Roger of Cambridge; a sister, Eleanor Haberstroh of Worcester and eight grandchildren. The sympathy of the class is extended to the families of these deceased classmates.—**Yardley Chittick**, Secretary, Rte. 1, Box 390, Ossipee, NH 03864

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Royal sterling has arranged our 65th reunion as follows: welcome dinner at hotel, June 1; lunch at Anthony's Pier 4, dinner at hotel, Pops concert, June 2; Technology Day luncheon, business meeting at hotel, banquet at M.I.T. Museum, June 3; lunch at Corinthian Yacht Club, Marblehead, dinner at hotel, June 4; and farewell breakfast at hotel, June 5.

Lem Tremaine is in Park Manor Nursing Home, 1312 W. Main St., Waterbury, CT 06708. Friends may wish to send cards.

Word has been received of the passing of **Jonathan Young Ballard** on June 22, 1987. He was an industrial executive and leader in the field of ice cream and dairy products. Born in Fort Worth, Tex., in 1901, he prepared at Exeter Academy and received his S.B. from M.I.T. in engineering administration. At the Institute he was a member of Beta Theta Pi fraternity, the Colonels, the Calumet Club, played on the golf team and was the wearer of the GTT. In 1937, he married Blanche Owens, a native Texan. He followed the profession of engineering for about 12 years, principally as an employee of a company which had ice manufacturing and dairy processing plants in the Southwest. About 1935, he advanced into the management of the concern and became executive vice-president. During this time he was involved in a company known as the Ballard Sales Co. as an officer and director. In 1945, he bought and operated an ice cream plant in Fort Worth until 1952, when it was sold. He devoted his efforts to numerous companies in which he had an interest. The Southland Ice Co. had begun to diversify into

PHOTO: DAVID GRAHAM, '87

the milk and ice cream business as well as to pioneer in the field of convenience stores. He worked very closely with this company as an officer and director, and it evolved into the Southland Corp. with a nationwide operation as well as international interests. He was vice-president, director, and trustee of the Pension and Profit Sharing Fund, in which the company was a pioneer. In all, his service to Southland extended for over 50 years. After 1947, he became fairly active in the affairs of Gulf Insurance Co., the largest of all Texas-based casualty companies. This association ended in 1969 when Gulf Insurance was taken over by University Computing Co. For many years he kept in touch with Institute affairs through Miss Olive Barnard and Professor Irwin Schell and, thereafter, with other Institute officials. He was for many years a member of the Educational Council and the Institute's Corporation Development Committee. He generously supported M.I.T., and in 1977 Ballard House in the New House dormitory was dedicated to him and his wife, Blanche. He had great interest in golf, played and followed the action of the professional golf tournaments and had the privilege of knowing and playing with most of the foremost professionals of his time. The class extends sympathy to his wife, Blanche, who survived and who resides at 1215 Hillcrest, Fort Worth, TX 76107.

Ida (Mrs. **Cecil Green**) died December 26, 1986. With her husband Cecil, she was a generous benefactor of the Institute. A memorial service was held at the Institute on May 1. . . . **Benjamin Drisko** died last May 10. He graduated with our class in electrochemical engineering. In 1948 he was a research engineer for Stevens Arnold Co. of south Boston. He worked with the Harvard Underwater Sound Laboratory and the M.I.T. Servomechanisms Laboratory for several years. . . . **Dale Washburn** died last May 8. He graduated with our class in electrical engineering. He also received a degree from Harvard Business School in 1946. He was vice-president and commercial manager at Boston Edison Co., retiring in 1966.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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In his class officer reorganization, President **Don Moore** announces that **Rock Hereford** now shares the duties of class secretary with **Russ Ambach**. A class agent to replace the departed **Dick Lassiter** is considered unnecessary.

The whooping is all over, but **Eric Brater** reached his 91st birthday on August 3. He entertained the guests by rattling off some Mozart and Beethoven on the piano and then taking them for a tour of his recently produced watercolor paintings. Eric has been a close friend of mine since we met on the first day at the Institute in 1920. . . . Your secretary was surprised by a phone call from **Jack Lurie** of Colorado, who was in Boston during June. He has several relatives who attended the Institute, which he visits annually. . . . **Don Moore**, **Don Fife**, **Russ Ambach** and Bob Stewart (son of the late **Herb Stewart**) attended the Technology Day alumni luncheon. We also took part in the morning memorial service for deceased alumni, including 20 class members. Don Moore and Russ socialized at the annual class secretary pre-luncheon cheese and wine get-together sponsored by *Technology Review*.

Ralph W. Bartlett died January 24, 1987, in Medomak, Maine, according to his sister, Nancy Bartlett Zahn. He earned his S.B. in business and engineering administration, and worked for the Stefco Steel Co., moving to Maine as their eastern representative. During World War II, he was a gunnery sergeant in the Marine Corps. He was a member of the Regional Planning Commission and Mid-Coast Association in Maine. . . . The wife of **Clarence M. Chaffee, Jr.**, informs us that "Bus" passed away March 28, 1987, of cardiac arrest in Washington, D.C. He earned his S.B. in mining and metallurgy. We do not have much information about his career except that in 1949 he was with the U.S. Treasury Department. He was a member of the Tau Beta Pi and a great M.I.T. booster, and in May he would have celebrated his 60th wedding anniversary. . . . **William Giddon** died on March 21, 1987, in Brookline, Mass., reports his brother, A. Arthur Giddon. William received his S.B. in business and engineering administration and began his career at Sanborn Medical Co. After five years, he shifted to R. H. Macy Co. as merchandising manager, followed by a stay with L. Bamberger Co. He moved to A. Sandler Co., Needham Heights, Mass., from which he retired. "Willie" was active at the Institute in various years, being affiliated with the rifle club, electrical engineering society, Corporation XV, and the Tech News staff. . . . We are indebted to E. William Cummings, '48, for informing us of the death of **Godfrey G. Kearful**. He is recorded with no degree, but we believe he did graduate work in electrochemical engineering. He was an innovative engineer, developing and producing a door latch in common use today, and a hydraulic valve for automotive steering produced by the millions. As chief engineer of plant and power engineering at Saginaw Steering Gear Division, General Motors, Saginaw, Mich., he retired to Florida in 1984.—**Russ Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Rock Hereford**, Co-secretary, Box 5397, Hacienda #90, Carmel, CA 93921

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Evelyn and I attended Technology Day, and I got together with **Sam Spiker** at the luncheon. Sam had expected Elinor to join us, but her duties as secretary of her class at Radcliffe prevented it. . . . A letter from **Ed Kussmaul** notes that he and Adele were about to leave Florida for the trip back to their summer home in New Hampshire on the shores of Lake Winnipesaukee. By the time you read this they will be about ready to return to Florida. Ed exhibited one of his oil paintings at the Briny Breezes Art Show in March 1987, and the painting received a number of votes for best of the show. . . . **Milt Salzman** writes, "I have recently returned from another Harmony 'Love Boat' trip to the Caribbean Islands with some of my Barbershop Chorus friends and their female counterparts, the Sweet Adelines. It was an enjoyable trip, flying to San Juan, Puerto Rico, and then cruising on the *Sun Princess* to Barbados, Mayeaux, Martinique, San Maarten, St. Thomas and St. John. Much congeniality, quartet singing, and interesting shore trips. Our local Barbershop Harmony Chapter recently put on a gala two-night show, 'Kollege Daze', which took me back to our Roarin' Twenties at M.I.T. I find this a great hobby to enjoy in later life and a good way to feel young."

It is my sad duty to report the passing of four classmates. **William F. Morton**, of Winchester, Mass., died on March 27, 1987, at the Fairlawn Nursing Home in Lexington. Bill went to Harvard Business School, graduating with the class of 1927. He then joined State Street Investment Corp., where he worked, except during World War II, until he retired as a senior partner in 1965, after which he operated a small management business of his own. During World War II, President Franklin Roosevelt appointed Bill as a colonel in the Strategic Bombing Command, which oversaw all military bombing operations during the war. Bill was one of the first to receive the Medal of Freedom, which Roosevelt presented to him in recognition of his work in the command. For 24 years Bill was active in directing Children's Hospital, and served as chairman of its investment committee. Bill was a past trustee of Radcliffe College. He was a director of Boston Safe Deposit and Trust Co., the Boston Co., the Boston Five Cent Savings Bank, and Winchester Hospital. He was a cofounder of Arvida Corp. of Florida, a real estate business, and was chairman of the executive committee of the Atlantic Seaboard Railroad. Bill leaves a son, William F., Jr.,; three daughters, Betsey Drusen, Susan Duncan and Prudence Horne; a brother, James A. Morton; a sister, Phyllis Morton; ten grandchildren; and a great-grandchild. . . . **Alfred Kullman**, of Glenview, Ill., retired president of the Onsrued Machine Tool Corp., died on February 10, 1987, at the Old Orchard Manor in Skokie. During World War II, Al served as a consultant to the government at Oak Ridge. Before assuming the presidency of Onsrued, he was vice-president and works manager of American Tool Works in Cincinnati. A creative inventor and holder of many patents, he is remembered as the developer of the machine that created the modern aluminum baking pan. Al was well known in the machine tool industry and was a member of national engineering and machine tool societies. A director of the North Shore Art League and a member of the Evanston Art League, Al was an enthusiastic student of art, especially in oils and watercolors, and was a prolific painter. Survivors include his wife Eve; a son, Bruce; a daughter, Anne Wald; and three grandchildren. . . . **John T. Crawford** died on March 27, 1987, in Green Valley, Ariz. . . . **Justin Peterson** passed away on February 18, 1987, in Hendersonville, N.C.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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Because **Bill Meehan** has had eye trouble, then a stroke and into the hospital for two months (now home, getting around, and looking forward to playing golf), I am getting this class news out. Don't expect this to be of the performance of Bill or **George Warren Smith**, who gave excellent service to the class news. If anyone is interested in taking over the class secretary position, please contact me or Sandra Knight at *Technology Review*, who will be collecting classmates' news in the interim. You know we belong to a wonderful class, and you people make it a great class.

We had our 60th in Cambridge for the first time, and all seemed to enjoy it. **Mark Greer** and **Austin Kelly III** state that our reunion gift was $2,004,347 with 78 percent participation of the class. Seven other classmates helped them. Didn't they and 78 percent of you do a grand job? . . . We are fortunate to have Liz and **Jim Killian** for our get-together before Liz passed on last November 27. . . . In addition to **Earl McMahen** describing how he got the neighbors to keep the lighthouse in view, he also told of his efforts to overcome the objections of town officials to moving an historic house up on the hill. I am afraid that Tech can't take all the credit, as his law degree had a lot to do with his successes. I have seen Earl's home and view of the lighthouse, and his efforts were worthwhile. Too bad Earl couldn't stay with us to enjoy his efforts. I am sorry to report that he died on January 15, 1987.

I met our classmate **Chia-Yank Shih** when we went with other M.I.T. alumni to Peking, China in 1983. He is still a professor at Tsinghua University and wanted to join us at the 60th, but he couldn't leave his students and a project he was working on. We correspond periodically. . . . **Frank Cramton** writes that Laura Anne and **Marty Grossman** stopped by to see them on their way to our 60th and hoped to visit the **Harry Howards** on the Cape. . . . **Don King**, who never misses a reunion, expressed his best wishes but was unable to make our 60th. . . . A recent newspaper article runs the headline, "Honeywell names conference room after Dr. Draper." We all know about many of his achievements, but we didn't know that he had been presented over 700 international honors and awards—our Dr. **Charles Stark Draper**.

Elton Staples writes that he and Helene are enjoying life in Chatham (on the Cape) and Winter Park, Fla., and seeing classmates at both places. They also enjoy trips to Europe and cruises. We have both lost our first wives. With Mary, I have

a wonderful life again with extensive travels. I hope that those of you who have lost your partners will find another. . . . **Don Chase** writes that he remarried last year, "so life is much happier and interesting now. I am still walking the golf course on Cape Cod, but the hills are getting steeper. I spend most of the summer there."

Corporate Leadership Awards were given in April 1987 to a number of M.I.T. graduates, including one of our own, "Kenneth P. Morse, chairman of The Standard Register Co. . . . **Charles Merritt** and his wife have moved to 3030 Park Ave., Bridgeport, Conn., a retirement resort. This is a beautiful place. I go there to see a close friend. . . . **Morris Minsk** is recovering from an operation.

William H. Latham, age 83, of Lewiston, N.Y., died last January 15 after a month-long illness. For more than 30 years, Latham was a top aide to the chairman of the New York Power Authority. He directed the construction of the authority's Niagara Project in the late 1950s and early 1960s. "Two great projects—at St. Lawrence and Niagara—stand as monuments to the engineering genius, executive skill, and sheer persistence of Bill Latham and those who worked with him," said Richard Flynn, the authority's current chairman. Latham was also an avid beekeeper and a good chef, having once prepared breakfast for President Herbert Hoover. He was active in numerous professional and civic organizations. He leaves his wife, Cecelia, a daughter, a son, two brothers, two sisters, and seven grandchildren.

Bird Kelly of Nantucket died, February 25, 1987. . . . **George Craemer** of West Hartford, Conn., died on January 12, 1987. He graduated from Dartmouth College before coming to Tech. . . . Margaret Doelger, wife of **William E.P. Doelger** died on November 19, 1986. . . . **Thomas MacDonald** died December 26, 1986. . . . **Jouis J. Darmstadt** of Nyack, N.Y., died on August 8, 1986. . . . **William Dixon** of Media, Pa., died February 9, 1987, and **Robert T. Hayes** of Dineba, Calif. died January 5, 1987. . . . **William H. Borghesani**, who was looking very good at our 61st reunion and Technology Day luncheon last June 5, had a sudden attack on June 12 and died in the hospital within two hours. If you're time has come, it is better not to have it delayed. Our condolences go to the families of these classmates.

It would certainly be great if more '26 classmates attended the Cardinal and Gray Society dinners and excellent speakers at Endicott House in Dedham in the spring and fall. You'd also enjoy the refreshments and talking with those from other classes on the porch and lawn before dinner.—**Donald S. Cunningham**, Acting Secretary, 27 Lowell St., Braintree, MA 02184

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Thanks to Assistant **Larry Grew** for most of the following notes on our 60th reunion. Memos were received from classmates unable to come: **Nat Cohn**, **Russ Westerhoff**, **Lee McCanne**, **Frank Staples**, **Charles Hurkamp**, who lost his wife Alice in February, **Walter Walker**, and Roger Nowland.

Some of us stayed at McCormick on campus, others at the Hyatt Regency nearby. Welcoming committees were on hand at both locations. White sailor hats were distributed to each enscribed '27-'87 and with **Doc Edgerton**'s "drop of milk" emblem on the crown.

Wednesday afternoon we enjoyed a bus tour of the campus. Lab visits included Doc Edgerton's Strobe Alley and the new Wiesner Building, where we saw the new hologram photography.

Thursday we enjoyed a bus tour of "Boston Today," a visit to Salem, going slowly down Chestnut Street's old houses, a stop in Selectmen's office in Marblehead to view some fine paintings highlighted by "Spirit of '76" by Archibald M. Willard in 1876. Then we went to the Eastern Yacht Club for cocktails, good buffet luncheon, and a class photograph on the veranda. Mrs. **Harold Heins**, Marblehead, Mass., showed her book, just published by Abrams, displaying her paintings of plants. Some of you may have seen some of her magazine illustrations—a beautiful book in the opinion of those of us privileged to see it.

Back in Cambridge, we had a buffet at the Student Center followed by the Pops Concert at Symphony Hall. We have through longevity achieved the dubious honor of sitting in the first or second rows! It was a fine concert directed by Williams instead of our old friend Arthur Fiedler.

Early birds Friday had breakfast at Sala de Puerto Rico on campus, while those at the hotel enjoyed live harp music. There was a memorial service at the M.I.T. chapel, where we noticed that '27 had the longest list of deceased members.

Kresge was the scene of the Technology Day program. The Alumni Luncheon was attended by more than 1,000, and our class contributed to the Institute (over the last five years) in excess of $2,169,000 with 93 percent participation!

Friday night included cocktails and dinner at the Hyatt, where we were joined, of their own choice, by President and Mrs. Gray. At the class meeting we promptly and enthusiastically voted in the class officers for another tour of duty. Doc Edgerton provided the entertainment. Saturday at breakfast, we said our fairwells on an individual basis, all having had a wonderful time.

Jean Arnold Becker and her husband attended the Pops Concert with us. They had just returned from Palm Beach where they won a significant achievement for themselves and our class. They won the world's championship in English croquet.

As time passes on, we have more deaths to report. Professor **Percy M. Roope** died on February 26, 1987, in Cambria, Calif. He was a professor of physics at Clark University, Worcester, until his retirement in 1962. Since then, he had lived in California, where he had been a consultant in physics and photography while enjoying his passion for good music.

Colonel **Robert T. Connor** died on March 17, 1987, in Fairfield, Conn. He retired from the U.S. Army in 1957 and retained his interest by memberships in the Officer's Club at West Point and the Naval Submarine Base in Groton. He renewed his academic life by attending University of Bridgeport and earned a master's degree in education in 1959. In 1967 he was elected to president of their alumni association.—**Joseph C. Burley**, Secretary, RFD 3, Epping, NH 03042; **Lawrence B. Grew**, 21 Yowago Ave., Branford, CT 06405

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We have a beautiful long letter from **Jay Monier** which comes close to the kind of minibiography we have been urging all of you to write. For the present, at least, we can give you his opening sentences then synopsize the rest: "It is many years since I last communicated but after becoming an octogenarian a couple of months ago I decided to make a small change in the situation. It is now 16 years since I retired as plant manager of the Savannah River Plant which is still operated by Du Pont for the U.S. Atomic Energy Commission. In case you never heard of the place you can find its 300 plus square miles in the southeast corner of South Carolina. I was with Du Pont 38 years." Jay goes on to say that he has since enjoyed a thoroughly pleasant retirement in Florida. A heart replacement valve installed in 1980 is still doing its duty and, although he now foregoes golf, Jay walks two miles every day, keeps up with household chores and has time for TV and reading. His wife Van is still going strong and guides the activities of her women's club in scheduling about eight trips per year.

The Technology Day luncheon in June saw a good representation of the class in attendance. Present were Frannie and **Jim Donovan**, **Newton Foster**, Janet and **Fred Lewis**, Ann and **Will Tibbetts**, Ruth and **Abe Woolf**. Our honorary classmate, **Shirley Picardi**, joined the group for a while and a dozen or more from other classes came to the '28 table to greet Jim. Two young guests from Germany accompanied the Tibbetts. Three customary regulars were absent: **Al Puschin** who expected to attend had to cancel because of a bicycle accident. The **Walter Smiths** stayed home because he was just out of surgery for a hernia repair. June 1988 is the big one for us so mark your calendars now and plan to be in Cambridge to celebrate with all your old classmates!

If you find it difficult or inconvenient to write please feel free to telephone us. It is a pleasure to hear from any of you at any time regardless of medium. We had several short but pleasant telephone calls recently: **Al Puschin** spoke of how he had been helped generously by our late classmate **Max Bearon** in getting his chemical sales business started. Prior to his illness, Max had been very successful in that same kind of business. . . . **Roger Haven** called with a brief report on '28ers in the area in and near Fryeburg, Maine. This included **Jim Tully** who, unfortunately, has had some health problems lately; and Louise and **Ernie Knight** who seem to be doing well. . . . **Lazare Gelin** checks periodically by telephone—mostly to stay in touch and to inquire about classmates. Lazare still travels and has made several trips to the Virgin Islands. His baggage was lost on the last one.

Dorothy (Mrs. **Carney) Goldberg** has been enjoying elder-hostel programs abroad. These have included nature, geologic and historic studies in Dundee, Scotland; pottery and porcelain in Keel, England; royal houses and gardens at Royal Holloway College in Eglam, near Runnymede, England. The last mentioned course included visits to Hampton Court with all its gardens and greenhouses. . . . Mary (Mrs. **Arthur A.) Nichols** writes proudly of her new great-granddaughter. At a large family gathering in Miami, Florida, the newcomer was christened as Mary Vanessa. . . . Marjorie (Mrs. **John A.) Carvalho** writes of her travel plans for this year which include three weeks in England, Wales, South Ireland, and Scotland, followed by two weeks in Oregon, Washington, and California. She is also looking forward to the next Cardinal and Gray Society meeting this fall and hopes to be at the 60th next June.

G. M. Solomons

With deep regret we must report that **Gustave M. Solomons** died on May 13, 1987. Gus graduated in Course VI, electrical engineering, his professional career was in electrical engineering, first with Bethlehem Steel Corp. Fore River Shipyard (30 years; until retirement) then with Boston Metropolitan District Commission, from which he also retired. Gus was prominently active in a variety of civic and social service groups. This included ten years as a Cambridge School Committee member (two years as vice chairman), officer positions in the Cambridge Redevelopment Authority, and member of various bank, hospital and public service boards. His outstanding public services were recognized when the City of Cambridge named a high-school building in his honor. Besides his wife, Olivia, Gus leaves his two sons, Gustave, Jr., M.I.T. '61, and Dr. Noel W., Harvard, '66, and Harvard Medical School, '70. The funeral services for Gus were attended

by Ruth and **Abe Woolf** and by Florence and your secretary. When the opportunity was offered, Abe, as reunion chairman, spoke briefly but warmly on behalf of the class.—**Walter J. Smith**, Secretary, 37 Dix Street, Winchester, MA 01890

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Louis Southerland of Austin, Tex., writes, "My wife and I travel a great deal, having recently returned from New Zealand and Australia, where I painted several water colors. Retirement is very enjoyable. My architectual designing firm continues on. The new young principals are doing great, which gives me much satisfaction. Thank you for my 81st birthday rememberance." Besides painting, Louis likes hunting (quail, dove, and turkey). . . . **John G. Howell** of Piedmont, Calif., says, "Still enjoy reading technical literature in my field and occasionally have put it to use. Most of my work is correcting errors of others and avoiding making mistakes myself." . . . **James C. Redding** of Webster, N.Y., writes, "I passed my 80th birthday about a month ago. Upon my return from London, where I had been digging into the library of the Royal Aeronautical Society and visiting Bomber Command's New Museum at Hendon, I went on to Galveston, Tex., for a month to watch my daughter, Mayor Jan Coggeshall, running that city with energy that tired me just to watch her. Galveston's revival is quite impressive, worth seeing."

I sent **Richard E. Bolton** of Canada a birthday card, as usual, for his 80th birthday. He replied, "Next week, I am off to Scotland then to York, London, and Bristol visiting some of my distant cousins who have been lifelong friends, as were our parents in earlier years and now are our children. I will no longer drive a car in Britain. My reactions are too conditioned by the customs of North America to be safe in Europe where the systems of traffic regulation are so different. In England, driving on the wrong side is probably the least of the difficulties, compared with yield marks on the pavement instead of stop signs. Our son Richard, a physicist in charge of Canada's nuclear fusion experimental program, has been appointed to the Science Council of Canada, a body which advises the prime minister on science priorities and budget. As you say, the 60th reunion is not far away. I have a strange feeling that I may make it somehow."

Larry Moses of Sarasota, Fla., writes, "Kay and I are both doing well as we approach our 55th wedding anniversary (September 2, 1987). Seventeen years of retirement in Sarasota have truly been 'Golden Years.' We have three children (ages 40 to 52) plus four grandchildren. I am proud to have graduated from Course VI-A in '29, with an army commission in 1930. My army career led to LTC rank in 1946 after five years of active duty in World War II and 41 years with New York Telephone Co."

Florence, wife of **Ted Malstrom** of Honolulu, Hawaii, writes, "Thank you for the birthday greetings for Ted's 80th birthday. I am also enclosing a picture of Ted and me taken on his birthday, showing the traditional Hawaiian lei (neck piece) which is made up of maili leaves and ilima, usually reserved for royalty. It takes thousands of petals to make the ilima pait. Our youngest daughter Polly came from Reston, Va., to help celebrate a small family affair. Ted is still getting around with a walker in the apartment, but he uses the wheelchair the rest of the time. We are enjoying our great-granddaughter who will be 2 years old in February. It was great having a visit from the Donahues and Peg Hill. We got to spend a week on the island of Kouai last July with all our family, including the mainland ones. It was great!"

Since the passing of **Arthur Bearse,** our ranks are further thinned to two at Technology Day 1987, **Putnam Cilley** and your secretary.

I regret to announce the deaths of the following members of our class:

Kenneth R. Fitch, Fontana, Calif., January 20, 1987; **Adolph J. Dietsch,** Sonoma, Calif., February 26, 1987; **Grace G. Farrell,** Brighton, Mass., March 21, 1987; **Emergy R. Low,** Baltimore, Md., May 3, 1987; **Fleming R. Hurt,** Waynesboro, Va., May 3, 1987.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

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The 1987 annual meeting of the Systems Dynamics International Conference was held in Shangai in June. China was the host country, and our classmate **Ching Yang,** who is director of the Center for Systems Dynamics Research at Shanghai's Jiao Tong University, was importantly involved in the arrangements. The principal speaker was Professor Jay W. Forrester of the Sloan School. By dint of numerous telex messages, Ching arranged for him to make pre-conference lectures at the Chinese University of Hong Kong and Shenzhen University, and a post-conference lecture at J.T.U., where Ching is on the faculty. The proceedings at J.T.U. included, in addition to Forrester's lecture, the dedication of a Forrester-Yang Systems Dynamics Reading Room. . . . **Robert M. (Jake) Jacobs** retired several years ago as senior vice-president and a director of Stone and Webster Engineering Corp., after a career in the nuclear field that included doing design work at the University of Chicago during World War II on graphite-moderated reactors, project engineering on the 30 Bev particle accelerator at Brookhaven, working on various nuclear power plants, and ending up in management. Like quite a few of our classmatates he now shuttles twice a year between Florida and the northeast—specifically Lexington, Mass.—with stops to visit his son in Philadelphia.

Melville Blackwood died on February 13. He had a varied career in such fields as textile development, chemical sales, plastics engineering, and electrical connectors. In the late 1960s, he switched from industry to teaching, and taught physics and mathematics at technical schools and junior colleges in Connecticut and New Hampshire. During the teaching part of his career, he used his free summers to build a house on a 15-acre tract of woodland in Sanbornton, N.H. After he retired several years ago, he and his wife Leola began spending the winter months in Silver Springs, Fla. My records indicate that in addition to Leola, he is survived by a son, William, a daughter, Barbara, and three grandchildren. . . . **Horace Myers** died on March 23. He was a commercial lighting specialist. From 1951 to 1968 he lived and worked in Hawaii, and then he moved to the Tampa area of Florida, where he was associated with Fife Florida Electric Supply Co. In 1973 he and his wife Isabelle built a home on Lake Joyce, where they were living at the time of his death. Horace had a massive stroke in November 1983, after which he was confined to a wheelchair and bed until the time of his death. Isabelle is his only survivor. . . . **Charley Abbott** died on April 10. He and I were prep school classmates as well as M.I.T. classmates; we were among the 12 members of the class of '26 at Phillips Exeter that went on to M.I.T. Charley worked throughout his career for power companies, first for Cambridge Electric Light Co., and after 1947 for New England Gas and Electric, from which he retired in 1972 as executive vice-president. Charley and Evelyn were longtime residents of Lexington, Mass., where he was a member of the Town Meeting, Planning Board, and Board of Appeals. In recent years the Abbotts spent their winters in Sarasota, where they were living at the time of his death. In addition to Evelyn, Charley is survived by two sons—Charles T. Jr., of Montgomery, Ohio, and William S. of Plymouth, Mass.—a daughter, Suzanne, of Lexington, Mass., and five grandchildren. . . . **Stanley L'Esperance** died on May 12. He spent most of his career in the Army Corps of Engineers. During World War II, he served with the 8th air force in England and thereafter became base engineer at West Point. After retiring as a lieutenant colonel in 1968, he lived in Belmont, Mass., and worked in the Boston office of H.U.D. as chief inspector in the design branch. Apparently his nearest surviving relatives are his two sisters.—**Gordon K. Lister,** Secretary, 294-B Heritage Village, Southbury, CT 06488

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We received a nice letter from **Larry Barnard**, 29 Kendal at Longwood, Kennett Square, PA 19348. In 1984, he and his wife sold their home in Wellesley Hills, where they had lived since 1941, bringing up five children, and moved to a non-profit retirement community run by Quakers in Kennett Square. Jan had chemotherapy treatments at New England Deaconess before they left but lived only a short while after the move. We apologize for the previous confusion over Larry's current address. Larry's two daughters live in West Hartford, Conn., and Painesville, Ohio, while his three sons are in Wayland and Carlisle, Mass., and Glen Mills, Pa.

Thank goodness we have no classmate deaths to report. The only thing I dislike about being class secretary is reporting deaths. We also have received no other news. Consequently, Helen and I might as well toot our own horns. We are leaving for a trip to the Canadian Rockies—flying to Chicago, changing planes and going on to Calgary, Canada. From there we take a bus, together with others, and visit among other places Banff and Lake Louise. Helen and I have never been to those places and are looking forward to the trip.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mt. Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

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Our 55th reunion ran off smoothly. Sixty-nine classmates and guests attended. The weather was perfect. Classmates were jovial and in good spirits. The program was well balanced—Pops on Thursday night, dinner at the 255 Restaurant in Boston featuring comedienne-lecturer Assistant Professor **Joyce Anisman-Saltman** on Friday night, and dinner at McCormick House on Saturday night with Dr. Irwin W. Sizer, president of the Whitaker Health and Science Fund, as the speaker. Between times there were lunches, sightseeing, Technology Day activities, and our own class meeting. We came, saw old friends and made new friends. The feeling was that we should not wait five years to get together again but should try to have a mini-reunion in two or three years. More of this in a future issue.

Perhaps the highlight of unscheduled entertainment was to hear and see **Tom Weston,** assisted by **Minot Bridgham** and **Donald Whiston,** singing "Technology" and other songs in the lobby of Kresge Auditorium. (*See photo, p. MIT 10.*) The large crowd of onlookers kept asking for more! In the evening after our class meeting, Tom led us in a singing fest and in an active interpretation of an Eskimo walrus song.

Elmer Stotz and his wife were in an automobile accident just prior to our reunion. They have been released by now. We all missed you, Elmer and Doris! . . . **Herb Ross** wrote that he had been

diagnosed as having cancer. He must undergo extensive treatment. We all hope you will respond well and will join us at our next reunion. . . . Mrs. **John Finnerty** informs us that John had a fall some time ago and is having problems. John, by the time you read this, we hope you have recovered from your fall.

Robert Semple has recently remarried and was planning to be in Europe at the time of our reunion. We missed you, Bob! . . . **Al Dunning** had to cancel out because of his wife's illness. We hope for a speedy recovery! . . . Because of health problems, **Don Gilman** was unable to be at our reunion.

A very moving memorial service was held at the M.I.T. Chapel for all alumni reported deceased from April 15, 1986, to April 20, 1987. Twenty classmates were remembered. More news about our reunion in the next issue.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Ivan Getting received an honorary degree from University of Southern California last June. . . . **Dick Payzant**, has moved with Emma from a big home in Olympia, Wash., to Gig Harbor. Lots of boats, yachts, fishing, Alaska fleet, etc. . . . **Forrest Dexter** reports second retirement, an occasional lecture at University of Maine, Farmington. Still giving talks to schools, encouraging students toward geology, chemistry, and physics.

Clarence Farr is doing industrial consulting at his son's printed circuit board plant. Last October he spent time with **Bob Smith** and **Mort Williams**, also had a hip replacement after a fall in New Hampshire's icy turf. . . . **John Longley**, with wife Lil, flew to England last December, their first visit since World War II, to visit their youngest son and wife and granddaughter. They drove for two weeks and visited only one museum and one cathedral (Salisbury).

As advised, in the last class notes, **Beau Whitton** arm-twisted the undersigned to be class secretary. He reported having a visit from Dot and **Bill Houston**, enroute from Florida, and that **Jim Norcross** was recovering from cancer of the throat. Beau's wife Daphne was in the infirmary for a period of weeks but, last we heard, was improving rapidly.

We regret to report the death of the following classmates. **Edward Bertozzi** died March 18, in Jupiter, Fla. His son, Edward Jr., resides in Rehoboth, Mass. **George Stoll** died October 18, in Pembroke, Mass. Mrs. Stoll may be reached at 45 Taylor Street, Pembroke, Mass. 12359.—**William B. Klee**, Secretary, Box 7725, Hilton Head Island, SC 29938

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In April the Institute conferred M.I.T. Corporate Leadership awards on 64 alumni who have held top positions in business, financial, and industrial organizations in the years 1984 through 1987. Among this group, **William H. Mills** was honored for his work as chairman of Mills and Jones Construction Co. . . . **Warren Kunz** says, "Still enjoying cruising on the Chesapeake—and visiting friends and relatives by land or sea." . . . **Harry Heiligenthal**, of Willoughby, Ohio, writes, "Too old and too sick—hope to live to 7/9/2012—age 104.42 years!" We're really all too old, and I hope "too sick" is part of Harry's joke.

At the end of May we received a great letter from **Johnnie Hrones**—the kind that brings joy to a secretary's heart. He covers so many contacts that it is worth quoting verbatim. Here it is: "I have often been on the point of writing you and have finally made it. I am still residing in Sarasota, Fla., but we are off to Jaffrey, N.H., early in June. I hope to make it to Alumni Day with John, Jr., '68. I continue to serve as president of A.I.T. Foundation, Inc.—a charitable educational organization largely devoted to helping support the Asian Institute of Technology, a graduate school of engineering in Bangkok, Thailand. I have been a trustee of the school since its founding. This business takes me to Cleveland and New York. . . . When in Cleveland I stayed with **Eddie Sylvester**, who is fine. He is still active with his firm, Sylvester Enterprises, developing new processes for the casting of steel. He had just returned from a trip to New Zealand and South Africa, where he has had business interests for a number of years. Eddie was a key member of the hockey team. . . . Another hockey player, **Roger Williams**, stopped to see us this spring. Roger and Lois are still in Hingham, Mass. Last year they missed their annual trip south because of Roger's illness. He appears to be fine now. They had stopped on their way down to see Barbara and **Frank Milliken** in Darien, Conn. Frank and Barbara have sold their place in Vero Beach, Fla. Roger was sorry to report that Frank is not well. . . . **George Bull** will be interested to know that Dick Lawrence, '35, now lives in Englewood, Fla. Dick followed George as manager of the hockey team. . . . I see Beth and **George Fowles** at meetings of the M.I.T. Club of S.W. Florida. George has been doing some teaching at Georgia Tech. . . . **Bill Leete** is in Sarasota and very active in local affairs. . . . Other members of the M.I.T. club are **Wally Bird**, **King Crosby**, **Gerry Hudson**, **Henry Humphreys**, **Wilfred MacDonnel**, **Walter Reid**, and **Charley Sanders**. . . . I see Mary and **Bissell Alderman** once in a while. Bissell is listed with the class of 1935 (he took the five-year Architecture Program), but he took most of his courses with us. He lives in Jaffrey, N.H., in a beautiful house with a magnificent view of Mt. Monadnock. He has served as president of the Sharon Art Center, and he was the architect for the remodelling of the Center."

Now that you others see how it's done, please get busy and help, too.—**Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815

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Our class representation at the Technology Day Alumni luncheon included **Leo Beckwith**, **Arthur Cohen**, Rhoda and **Bernie Nelson**, and your secretary—plus **Warren Seamans**, our honorary member from the M.I.T. Historical Museum. Much of the conversation was relative to the "where" and "when" of holding a mini-reunion in the Fall of 1988. There has already been at least one mini-reunion in our class—small, though exceptionally satisfying, in distant, exotic surroundings. Late last February, Cele and **Ed Taubman** were in Honolulu enjoying life when Rhoda and **Bernie Nelson** arrived. They promptly joined forces and the Taubmans proceeded to host a two-day two-night reunion doing whatever everybody does when they visit Hawaii. Bernie says there was nothing "mini" about it except that there were only four persons. Which leads up to this: If you have any comments or suggestions for a mini-reunion, please let Bernie or me hear from you.

Here's a note from **Jeff Farmer**: "Mountain Home, Ark., has to be our last home. In the past every issue of the alumni directory has caught us in a move, too late to be listed correctly, but no more. Great retirement area. Lakes and woods similar to New England, but it sure is off the beaten path." . . . **Franklin Yates** also sends a note: "I am gradually getting back to normal living after my wife Marjorie had open-heart surgery. She had an aortic heart valve replacement. She is making a good recovery now, after an initial set-back after she reached home." . . . On June 25, 20 scientists and researchers, including three from New England, received the nation's highest science award from President Reagan, the National Medal of Science. One of the recipients was **Walter Stockmayer**, Dartmouth College chemistry professor emeritus. . . . A brief note from **Les Brooks** says that he is starting a small garden instead of looking for a smaller place to live. He also states that he hits a few golf balls out back nearly every evening. A warning to golfing visitors: Les' last score was an 88. He's still in Rockmart, Ga. Les also writes, "We're fine, just falling apart slowly."

I regret to report the deaths of three classmates who attended our 50th. Following is a letter written by E. Philip Kron, '34, to the Alumni Fund: "The enclosed check to the 1986-87 Alumni Fund is in memory of **Roger S. Brookman**. Roger was a very close personal friend of mine from the time he entered M.I.T. in 1931. We were fraternity brothers (Phi Delta Theta) and roommates. He introduced my wife (of 50 years) to me, and we worked together at Kodak in the early years and later for a few years as manufacturer's representatives in Buffalo, N.Y. I shall miss his friendship, leadership, dedication, and inspiration. My world is better because he lived in it." . . . **Al Frank**'s widow, Ann Burton-Frank, writes, "Al enjoyed attending the 50th reunion in 1985. As a result of information located at that time he visited with several of his classmates. He really enjoyed those visits. Al was president of a small manufacturing company, Frank and Warren, until his retirement in 1975. We were married three years, spending half of each year in Key West and the other half traveling. Returning from Southeast Asia this winter he was a little tired—the first symptom of the cancer from which he died April 25." . . . "It is my sad duty to inform you of the death of **Nelson Howard Thorp,**" writes his granddaughter Diana L. Thorp. "Nelson was born on August 20, 1912, and died on April 28, 1987. He is survived by his wife, Merle N. (Baxter) Thorp; one son, Neil Howard Thorp; one daughter, Sandra H. (Thorp) Thornton; and four grandchildren."

I have been trying to get in nine holes of golf on a Saturday or Sunday afternoon when the weather is good. I play at the Martin Memorial public course in Newton/Weston/Wellesley. Recently, I was placed with a trio of two men and a woman in their mid-20s. My day was made when, walking down the second fairway, we discovered we were all graduates of M.I.T.!

I am pleased to announce the arrival of Jessica Ann Mowatt, my 11th granddaughter, on May 11 to Kay and Chris in Westfield, Mass. So far there are no grandsons. Chris' brother Peter's wife Maria is expecting their first about the time you are reading this. We will then find out if "mirror image" applies to sons and daughters too. Chris and Peter are mirror-image identical twins!—**Allan Q. Mowatt**, Secretary, 3-120 Pond St., P.O. Box 524, Waltham, MA 02154

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Lucky **Laddie Reday** and Peg covered the America's Cup races in Australia for the publication, *Waterfront*. Along the way he explored "the unspoiled east coast of Malaysia in quest of the white crocodile—which I doubt exists." He sent a card air mail from Kuala Lampur, but apparently it came via slow boat from China, taking five weeks to reach Pleasantville. In June these two adventurers hiked one hundred and twenty miles from Florence through the hills of Tuscany.

From the Alumni Association has come word of the death of **George Temple** on March 15, 1987. A phone call to his widow, Lorraine, revealed that George's promising career was cut short by the onset of Parkinson's disease twenty years ago just after the family had moved to Cumberland Center, Maine. Dementia plagued him the last few years. With love and devotion and some help Lorraine cared for George to the end at home. Lorraine, who was secretary to Dr. Sam Caldwell, director of the M.I.T. differential analyser project under Dr. Vannevar Bush, met George who was an assistant on that project. They were married in 1938. Later George participated in Dr. Harold Ed-

Nancy and Joe Keithley share cocktail time before dinner at Wequassett Inn during his 50th reunion. Keithley and George DeArment, reunion gift chairmen, helped to raise $4,787,000, the second largest 50-year gift in M.I.T. history.

gerton's stroboscopic light demonstrations at the 1939 New York World's Fair. If you were there, you may have seen him swinging a golf club before the strobe lights. Before his illness George enjoyed hiking, mountain climbing, and sailing. I expressed condolences on behalf of our class.

Notice also was received of the death on December 28, 1986, of **Richmond Eddy** of Jamaica, N.Y. who studied architecture but left before receiving a degree. I have no other information.

Let us salute the memory of our departed classmates, George and Richmond.

A letter from **Ariel Thomas** in April said he and Avis would soon leave for six months in Rhode Island. "Had a prostatectomy about a month ago. Seem to be recovering well." They had a busy winter in Florida with time for a cruise in the Virgin Islands, Christmas week with their daughter's family in Indiana, and New Years in Atlanta. "Avis and I are doing great."

George Parkhurst writes, "Barbie and I are moving from Chelmsford, where I have always lived, to the neighboring town of Westford, where Barbie was brought up. About four years ago Barbie sold her farm that had been in her family (the Hildreths) continually from 1680. "Hildreth Hills" condominiums were built and we purchased one of them about two years ago. The view is spectacular; we can look over to Mount Wachuset (30 odd miles to the west) and, from some of the units, the Hancock and Prudential buildings in Boston are visible. I don't consider that I am leaving my home town, even though the early ancestors of Barbie and me were living in Chelmsford in 1654, because Westford was part of Chelmsford until 1729." Their new address is: 14 Monadnock Drive, Hildreth Hills, Westford, MA 01886.

George enclosed a clipping from "The Sunday Sun," Lowell, Mass. showing **Aaron Loomis** and Natalie with samples of over 400 models of toy wooden racing cars, cranes, trains and sail boats made in their home "vehicle assembly plant." Aaron's love for working with wood and making some sturdy toys for his children during World War II has bloomed, as he says, into a "paying hobby, but we try not to make any money." Aaron retired after 33 years with Simplex Wire and Cable. Natalie, a retired first grade teacher, handles the "art work" in the laundry room where she paints colorful designs and faces on the drivers and adds other vehicle details. They give away almost a quarter of their output to libraries, hospitals, schools and others including an orphanage in far away Bangkok. They also donate the proceeds of craft show sales to the sponsoring organization such as the YWCA, Arts and Audobon Societies. Special needs students in an area program benefit from gifts of their time and toy kits for assembly as developmental projects. Our hats are off to Natalie and Aaron for sharing their talents so unselfishly in their "retirement."

Our class treasurer, **Eli Grossman**, recently reported no outstanding liabilities and a modest balance which he is prudently investing for a good yield.

Reminder: Mini-reunion on October 24, 1987 at **Alice Kimball**'s home at 28 Hartland Pond, P.O. Box 31, West Hartland, CT 06091 (203) 379-3807. Phone Alice if you plan to attend.

By the time you read this, **Frank Phillips** and Phoebe will be home from their journey in Europe. So rush your news via telephone. Before 8 a.m. and all day Saturday it is cheap for one minute. Frank has Reach-Out-America service. All he needs is your telephone number to call you right back for your news.—**James F. "Pat" Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171; **Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745

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Our 50th reunion was a huge success; 105 class members attended at least one of the events. At 9:15 a.m. on June 1, 26 of us put on our 50-year cardinal blazers and met at Rockwell Cage. Led by our class Marshall Dick Young we proceeded to the Student Center Promenade where the commencement procession began, we continued to the Massachusetts Avenue crossing, down Massachusetts Avenue, on to Memorial Dr., and ended in an assigned seating area in Killian Court, where we participated in the 1987 graduation ceremonies. Many of our wives sat with us. Most of us then attended the president's reception and lunch following commencement in Eastman Court at the rear of Hayden Library.

The applause of those attending the graduation, surprised to see 26 of us still alive and interested, was gratifying. On Thursday, June 4th, 89 classmates and 80 wives attended the president's reception at the president's home, the banquet which followed at Walker, and most of us went on to see the Pops. On Friday we were well represented at Tech Day and the alumni lunch where our class gift of $4.8 million, the second largest ever given, was announced. Seven of our classmates gave over $100,000, three over $500,000 and one over $1 million. On Friday afternoon, June 5, 70 classmates, 58 wives, and three widows drove to Chatham on Cape Cod where we stayed at the Wequassett Inn. Four additional classmates and three wives attended luncheons and dinners at Wequassett.

The Wequassett Inn was beautiful. We started off shortly after arrival on Friday with a cocktail party followed by dinner. On Saturday many of us sailed, golfed, played tennis, swam, went on sightseeing trips or shopped. There was plenty of time in between to visit with old friends.

A class meeting was held after our banquet on Saturday, June 6th. **Philip Peters**, our class president, presided, and 70 members and their guests attended. The Secretary's and Treasurer's reports were read and accepted. A nominating committee of **Bob Thorson**, chairman, **Phil Dreissigacker** and **John Nugent** presented the following slate of officers who were elected unanimously: president **Phil Peters**, vice president **Dick Young**, secretary **Les Klashman**, treasurer **Ralph Webster**, class agent **John Fellouris**, class estate secretary **George DeArment**, reunion gift chairmen **George DeArment** and **Joe Keithley**, reunion chairman **Dick Young**."

Phil Peters also paid tribute to the 28-member reunion steering committee, **Art Zimmerman** for providing general entertainment and past reunion notes, **Philip H. Dreissigacker** for arranging for a display of past reunion pictures, **Ralph Webster** for taking care of all finances and leading registration at McCormick, **Rutherford Harris** for the dance music, **Len Seder** for sightseeing, **Sid Levine** as reunion book editor, **Bill McCune** for providing polaroid pictures of each alumnus and wife, **John Nugent** for furnishing each class member a gift of 8 ounces of his Vermont maple syrup, **Pete Reitz** for his gift of the tapes of sounds of M.I.T. '39, and Marg and **Dick Young** for their work to insure that our 50th reunion was such a superb affair.

Pete (700 Mexico Place, Palos Verdes Estates, CA 90274) writes, "Enclosed is a cassette test tape that I have made containing some nostalgia about M.I.T. and the '33-'37 period. Side one is a reconstructed recording of *Sounds of M.I.T. 1939*, which I originally made for the Alumni Association, while on the electrical engineering staff in 1939. It was originally distributed to alumni meetings that year, and I have kept the master recordings throughout the years. I thought it might be a good idea to give a copy of this tape to all the '37 alumni attending the 50th reunion in June. I will have these tapes professionally duped to be distributed at no expense to the class. Side two contains 15 of the most popular songs of that era. These also are reconstructed from the original 78 RPM recordings. Collecting big band recordings has been a hobby of mine for years. My total library at present is well over 4,000 LPs, and 1,000 78s."After playing the tape on both sides, I immediately called Pete to accept his generous offer and **Dick Young**, our 50th reunion chairman, arranged for the receipt and distribution of the tapes to anyone who responded to any of the 50th reunion mailings.

Robert Thorson, our former class secretary and crew member, furnished the following report: "Prior to our 50th reunion it was suggested that we try to organize a nostalgic row on the Charles as part of our reunion activities. I was able to target 15 members of our class who had previously rowed and who had indicated they planned to attend the reunion. A questionnaire was sent and the responses were: 'Will the shell take the added weight? I catch crabs. Thanks for the opportunity, but no. Don't think I'm in shape. Sounds interesting, but I feel too old and stiff in the joints.' With these 'enthusiastic' responses, we abandoned the idea of a row and instead decided to hold a meeting at 10:30 a.m., Thursday, June 4th, at the boathouse, followed by luncheon at the Hyatt rooftop restaurant. At the appointed time we arrived and three of us, **Norm Birch**, **Jim Newman**, and **Bob Thorson**, changed into crew uniforms and had a stimulating row in the boathouse rowing tank. To our amazement we discovered we could take up the beat and stay in unison. No one caught a crab or swamped the boat. Jim Bidigare, of the Friends of M.I.T. Crew, congratulated us and presented the three rowing members with Tech crew T-shirts. He then conducted a tour of the M.I.T. Pierce Boathouse, new to us as it was built since we last rowed. (The old boathouse is now used by the Boston University rowing crew). We learned with great interest that the oars now in use worldwide, as well as some of the shells and indoor rowing machines, are manufactured and supplied by Concept II, Inc., a company owned and operated by classmate **Phil Dreissigacker**'s two sons, Pete and Dick Dreissigacker. Dick rowed for the United States at the 1972 Olympics.

After testing all the equipment used to build back, stomach, leg and arm muscles, we adjourned to the Hyatt for nourishment." On May 15th Dick Young notified those planning to attend

PHOTO: BARRY HETHERINGTON

our 50th that **Charlie Dierksmier**'s wife died only one month ago. . . . **Tom Hallenbeck**, recently aggravated his long-time, incapacitating condition and could not attend the 50th. . . . **Leo Moore** is suffering from problems which are undescribed but for which the medical people have not found cures. **Jim Schipper**'s wife's health problems prevent them from coming. **Ed Olmstead** hopes to make it but his wife too has serious medical complications."

It is with deep regret that I report the death of **John Jacobs** (1200 Brookyard Way #311, P.O. Box 431, Richmond, CA 94801). He and his wife Betty were driving back from Squaw in February 1987 where John had been skiing when he suffered a stroke and drove off the road narrowly missing an accident. He died with his head on her lap. He leaves two daughters.—**Lester Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155 (617) 391-2159

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Your secretary returned from Great Britain just in time for the class mini-reunion held at M.I.T.'s Endicott House in Dedham last June 5. It was quite appropriate that 1938 had 38 attendees. The mailing to the class raised a reply from **Bruce Old**, who couldn't come because he just had a hip replacement. Bruce still lives in Lincoln, Mass. . . . **Wilbur Rice**, still living in Bennington, Vt., also turned us down because he was in a hospital, reason unknown.

You will note that these notes are not in **Ed Hadley**'s inimitable poetic style. Speaking of Ed, he asks that I remind you that the 1938 Scholarship Fund is only a little over half way to its million dollar goal with only eight months to go. It needs more from all of us. Those of you who have contributed to the Fund will be interested to know that the income has already been put to good use. Three sophomores—Michael Petro, mechanical engineering, and Stephen Malinak and Kenneth Patrick, electrical and computer science—have received scholarships to supplement their income from part-time summer jobs.

Russ Cole, Pacific Grove, Calif., reports that he is still chief scientist for Planning Research Corp.'s Scientific Support Services at Fort Ord. His English wife, Ellen, recently put on a Victorian tea for the M.I.T. Club of Northern California.

We received belated notice that **Bill Roper** passed away last year in Sedona, Ariz. Bill had a long and distinguished career with the Army Corps of Engineers and retired as a major general.

Ab Towers died of leukemia in Atlanta last March. Ab had been a chemical engineer and owned his own business, Ajay Chemicals, Inc. in Powder Springs, Ga. He is survived by his wife Margaret and three children.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Phil Bush retired from Kaiser Steel and Kaiser Engineers and writes, "I retired ten years ago, am in great health, do management consulting for both non-profit and profit organizations. Margie and I had our share of great travels, including seeing the Seykotas in La Jolla. We feel lucky living in northern California but my luckiest break was being an M.I.T.er and particularly a 39er. We 39ers graduated at the right time, have had, on average, a very good life and owe much of it to M.I.T. I hope to do something extra for our 50th in 1989. Have been planning on it for a year and, God willing, I'll be able to do it. . . "

Larry Perkins is not ready to retire from his newly-expanded four corrugated-box manufacturing plants and he reports he and his family are happy, healthy, and into house remodeling, too.

Wiley Corl reports from Boca Raton: " . . . Enjoyed three weeks in Rio de Janeiro. Looking forward to our 50th! Enjoyed visits from Billie and **George Cremer** and Aletta and **Bob Touzalin**. . ."

Roy Haworth writes from Florida: " . . . Live on a golf course which also has its own airport. Many pilots have homes with attached hangars. My golf is not improving, but life in sunny Florida (Daytona Beach) sure beats snowy weather in Detroit. . ."

George Cremer and Billie travelled from their Rosarita Shangri-La on a 10-day railroad tour to Mexico's central mountains and copper mines. They commented on noticeable S-turns on not less than 37 switchbacks up and down the mountain part. On return to their Lemon Grove home they enjoyed a visit from **Gordon Pope** and Trixie.

King Cummings was headlined as "King of the Mountain" in the Portland, Maine *Sunday Telegram* and its article crediting King with bringing the Sugarload ski area from bankruptcy to solid financial health in a year's time. King, some of your classmates would wish you to repeat this magnificent achievement, but next time on the Federal Government!

We are saddened by news of the deaths of two classmates: **Richard Novak** in Boston during April. There were no details. **Benjamin A. Howes** in Bloomfield, Conn., May 28. Ben's career included engineering with Pratt and Whitney Aircraft Corporation and the Ford Motor Company.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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Plans are underway for our 50th reunion in June, 1990. **Ed Bernard** recently drove to Mystic Connecticut to scout out the area and the facilities. As a result, and after reviewing his findings with class president **Jim Baird**, a reservation was made, tentatively, at the Mystic Hilton for 100 rooms for Monday, Tuesday, and Wednesday nights preceding graduation and M.I.T. Night at the Pops. The Hilton is a medium size hotel with pleasant rooms, and facilities to provide us with private dining in the evening, and a buffet breakfast for several hours in the morning.

As a result of the request from **Bill Schnorr** in the July class notes for information about **Hank Rappaport**, I had a telephone call from **Milt Green**. Milt said that he visited with Hank last May at the University of California, Berkeley, where Hank is in the Chemistry Department. He is known internationally for his work in this field. Milt took early retirement from Polaroid five years ago, and is enjoying his leisure in Newton Centre, Mass.

Andrew F. Kay, Chairman and chief executive officer of Kaypro Corp. was presented with an inscribed Paul Revere Bowl last April 24 by M.I.T. president Paul E. Gray and M.I.T. Corporation chairman Dr. David S. Saxon in a ceremony recognizing distinguished corporate leadership by M.I.T. alumni. The recipients are honored for their exceptional contributions to the continued strength and well-being of the economic system.

Marshall D. McCuen writes from Indianapolis, Ind., "Have thoroughly enjoyed retirement for nine years. In ten overseas trips, I have visited over 40 countries. While home, I fill time with volunteering, sailing, and golf. Plan to make the 50th as I did the 40th and the 45th." We all look forward to seeing you again, Marshall.

Sadly, we must report the deaths of two classmates. Mrs. **Marie Haugan Johnson**, of Princeton, New Jersey, died on March 27, 1986. Marie was a member of the M.I.T. Club of Princeton, of the Present Day Club of Princeton, and had been a volunteer worker at the Medical Center at Princeton for 25 years.

Harlan H. (Hal) Davis died suddenly on May 2, 1987. Hal had served on the M.I.T. Educational Council for over 30 years. A Course II graduate, he had his own business as a manufacturers' representative, handling mechanically oriented items such as teflon, O-rings, and hydraulic cylinder rebuilding services. His son is also an M.I.T. alumnus. We send our deepest sympathies to the families of both these classmates.

Please keep the letters coming with information about your doings.—**Richard E. Gladstone**, Secretary, 1208 Greendale Avenue, Needham, MA 02192

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We have just received word that **Elihu Craig Thomson** died unexpectedly at his home in Wellesley, June 3, 1986. He graduated from Milton Academy, Harvard and M.I.T. He was vice president and chief engineer of the Electronics Corp. of America in Waltham, Mass. He worked for that firm for 40 years until his death last year. His wife Marjoree Woodbury Thomson said that he basically developed photo-electronic sensors from their initial stages into the sophisticated controls they now are. He invented many of the photo-switch products now being sold by his firm. Besides his wife he is survived by his children, Lynne Thomson of Brooklyn, N.Y. and Stuart Thomson of Chelsea, Mass.

George Hoagland Vineyard died of cancer, March 15, 1987. The University of Missouri, Columbia, is creating a chair in theoretical physics in his honor. After taking his B.S. and Ph.D. at M.I.T. and working in the radiation laboratory, Vineyard taught at the University of Missouri for six years. He was Director of the Brookhaven National Laboratory from 1973 to 1981. "He was a very careful, thoughtful, smart man," said Nicholas Samios, Brookhaven director. "He was a storyteller, a golfer, and an easygoing gentleman." George's interests were eclectic: vintage wines and Mark Twain, oysters and outrageous puns, good music, Emily Dickinson and spy stories, French restaurants and reading to little people. "He has enhanced the frontiers of physics, providing an increasingly complex society with new insights into basic research."

George had a mischievous sense of humor, he christened one of his sophisticated computer programs, "Grape" a reminder that science can be fun. At the time of his death he was serving as chairman of the steering committee of the Materials Research Council of the Defense Advanced Research Project, editor of Physical Review Letters, chairman of the National Allocation Committee of the John von Neuman Computer Center in Princeton, N.J., and this year president-elect of the American Physical Society. Mr. Vineyard is survived by his wife, Phyllis, of Bellport, Mass., two children, John H. of Ithaca, N.Y., and Missy of Northampton, Mass.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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If you were not among the 51 classmates and 48 spouses at Cambridge and/or the 65 classmates and 61 spouses at the Woodstock Inn, you missed one super 45th reunion! Muriel and **David Baltimore** and their committee did a wonderful job and got unanimously elected to do the 50th reunion. There was some talk of having it at the Woodstock Inn again. The golfers are all for this because some of us might get to reclaim all the balls we hit into the creek on the Woodstock golf course. Had to hit over that one brook 11 times in 18 holes.

Got lots of good stuff. For instance, did you know that: **Chris Magdsick** has "MIT '42" on his car's license plate? **John Lacy** has lost 50 pounds (net) since graduation? Many of us have lost hundreds of pounds more than this, but not on a net basis. **Dick Gannon** is still selling Chevies and Olds in Providence? **Bart Hakan** is on the Board of Directors of Nobel Prize winning Linus Pauling Institute. **Dave Baltimore** imported The Smurfs to the US and got them promoted by NBC. **Jack Sheetz** (and perhaps a third of our re-

tired classmates) is consulting in computers. Amazing, when you realize that all we had was slide rules!

In case you were staying up nights worring about it, your class officers were renominated and, after a hectic multi-million dollar political campaign of about 30 seconds duration, were re-elected!

Here are some interesting (?) statistcs from the reunion questionnaire. It was sent out to the whole class. Only 80 of us replied and all of those did not answer all of the questions. **Muriel Baltimore** also commented that some of the answers were "ambiguous!" How she got all this out of 80 replies, I really do not know. But anyway: married, 138; single, 55; divorced (once), 27; divorced (twice), 2; grandchildren, (272); great-grandchildren, 2.—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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William J. Vallette has been appointed to the New Hampshire Board of Engineers, Architects and Land Surveyors by Governor John Sununu, '61. . . . **Thomas K. Dyer** of Lexington, Mass., retired last May as president of Thomas K. Dyer, Inc. He expects to stay busy as a rail transportation counsultant. . . . A press release announces that **Ward J. Haas** has joined the Manhattan Consulting Group, New York City, as a principal of the firm. He will assist client firms to improve their research and development effectiveness. Ward previously served as vice-president for research and development at S. C. Johnson and Son, Warner Lambert, and Chesebrough-Ponds.

A letter from **George Freedman**, of Wayland, Mass., reports that he retired after 40 years with Raytheon, where he was noted for his long-term survival ability. George's retirement gift was a hammock, with which he claims to be a regional champion. He continues as a part-time consultant, and is also authoring a book for American Management Association, called "Organizing for Innovation," with publication set for early 1988. . . . George sent along a story clipped from the *London Times* about Air Chief Marshal **Siddhi Savetsila**, foreign minister of Thailand, who was about to undertake a diplomatic journey to the Soviet Union, East Germany, Poland, and Czechoslovakia, with the object of discussing "the Cambodian problem." . . . More news about Class of 1943 Career Development Professor **Sylvia Ceyer**. She has received the 1987 Edgerton Award for excellence in research, teaching and service to the M.I.T. community. She has also been advanced from assistant professor of chemistry to associate professor. . . . **Dick Feingold** sends additional information about the 45th reunion. Key positions are now filled by **Hans Walz**, treasurer; **Kemp Maples**, registration; **John Ward**, campus activities; **Gene Eisenberg**, souvenirs and gifts; and **Jean Hartshorne**, transportation . . . **Richard Berry** died April 19, 1986, in Pinehurst, N.C.—**Bob Rorshach**, Secretary, 2544 S. Norfolk, Tulsa, OK

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Scott Carpenter has been appointed vice-president of marketing for C.F. Systems Corp., a subsidiary of Arthur D. Little, Inc. He had been a vice-president of Cabot Corp. and for 15 years was general manager of its Cab-O-Sil Division. . . . The University of Maine, at the 1986 College of Engineering and Science Annual Banquet, bestowed the Ashley S. Campbell Award on Professor **Walter Turner**. This award gives recognition to a faculty member who has by his activities, achievement and scholarship brought distinction to the education of engineering and science students. The criteria for the award include: teaching effectiveness, achievements in engineering, research and public service, and professional and scholarly accomplishments. Walt has completed 39 years of teaching at the University of Maine in all areas of electrical engineering and will go into phased retirement next year. . . . **Robert W. Nietert, Jr.**, writes that he retired from G.M. in Dayton, Ohio, in 1980 and moved to Northwoods, Wisc., in 1983. He makes annual trips to Florida and California to visit grandchildren. . . . **John G. Barmby** reports that he and **Stan La Vallee** have been with the U.S. General Accounting Office in Washington, D.C., for 15 years saving taxpayers money by auditing Defense Department programs. Both are senior technical advisors performing weapons analysis to support line evaluators. . . . **Robert G. Fisher** sends word from Tallahassee, Fla., that he is a consultant to a textile manufacturer. . . . **Alfred C. Thompson** retired from Riley Stoker Co. in Worcester, Mass., last December, where he was an engineering manager. . . . **Stanley W. Warshaw** has moved up from president to board chairman of Sarnafil, Inc., Canton, Mass. (subsidiary of Sarna Polymer, Inc., Switzerland).

Your reunion committee met on June 25 at **Stan Warshaw**'s home in Newton to continue discussion of possible locations for the 45th reunion in 1989. Present were Stan, Ruth and **Norm Sebell**, **Janice Kispert**, **Melissa Teixeira**, **Jim Baird**, **R.J. Horn**, Marguerite and **Ed Ahlberg**, Dorothy and **Ed Woodworth**, Jane and **Lou Demarkles**. Also present was a travel agent to help us in our delibrations. Norm, our class president, reported a wonderful response to his letter asking for suggestions on where to hold the 45th: Responding were **Bill Van Ravenswaay**, **Peter Quattrochi**, **John Burdakin**, **Stan Hammarstrom**, **Jim Hield**, **Trigg Noyes**, **Robert Smith**, **Randall Pratt**, **Warren Howard**, **Will Rodemann**, **Ed Eaton**, **Al Picardi**, **William Richardson**, and **Charles Simpson**. . . . The Technology Day luncheon on June 5 was attended by **John Breymann**, **R.J. Horn**, **Andy Corry**, **Melissa Teixeira**, **Robert Smith**, **John Taft**, and Jane and **Lou Demarkles**.—Co-Secretaries: **Andy Corry**, Box 310, West Hyannisport, MA 02672; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Well, here it is the 4th of July and I'm playing catchup on the yard, garden and crumbling house after a long weekend in Santa Fe, a short week at Ghost Ranch, N. Mex. at a Quaker Yearly Meeting, and a long hard week northwest of Durango where I led a volunteer work crew building a segment of the 400-mile Colorado Trail we hope to complete this year.

I rubbed hands with **Ted Church** while at Ghost Ranch. Seems he's about as uncertain as I am on retirement. We're both looking at a couple more years—Ted from Sandia National Labs and I from Hughes.

Then there's this batch of odds and ends that have been collecting since April, like: An *Eos* magazine news clipping, sent by **John Knause**, which notes **Bill Brace**'s reception of the American Geophysjcal Union's most prestigious *Walter Bucher Medal* for contributions to the basic knowledge of the earth's crust. Thanks, John: I'm duly impressed.

Stan Ruttenberg, who lives nearly next door in Boulder, writes that he's ending his 12th year as Secretary General of the International Association of Meteorology and Atmospheric Physics. Along the way he also served as NAS's Technical Production Consultant to WQED's Emmy Award PBS series *Planet Earth* and received a special award from the Academy of Television Arts and Sciences; also was Director of the Computer Science Network. Also through the pipeline a news release telling of **Richard Curry**, an old Course X'er with an MS to boot, presenting a paper on "HVAC Integrated Testing and System Simulation" at Sargent & Lundy's Annual Conference in Chicago. Dick is currently serving as senior safeguards engineer in their nuclear division. He lives in Oak Park with wife Dee, and they have four children.

A sad note, sent by President **John Gunnarson** reports the death of **Herb Keating** who passed away in Scituate in early April. Herb was a Course XIIIer who ended up running his own marine engineering consulting firm for 25 years after doing time with the Navy Shipyard in Bath and other places. He is survived by his wife Mary, three sons, and four daughters.

Finally found some information on old Philadelphian and Company 7 hall mate, **Bill Peirce**, who's run the gamut of industry and academe (including a Ph.D. in Math at the University of Wisconsin) and has been running his own accounting show in Stonington, Conn., the last 18 years. He hopes to retire in ? years and spend more time with wife "Jimmy" at their camp Down East in Rangeley.

George Phillips, a real Marine Engineer (and originally from Annapolis), continued in the Navy and became involved in the conversion of the submarine force to nuclear power, getting his Master of Science in that field along the way. He got his best licks in designing and operating deep submersibles, most notably the Glomar Explorer (whose exploits I remember so well). He became vice president of Global Marine in 1978 and has been involved in ocean floor mining all around the planet. He's also taught occasionally at UCLA and Stanford. He's currently living in Katy, Tex.

Final discovery was **Ed Potter**, good ol' XVI buddy, who's been "hiding" in Westport, Conn. (a very nice neighborhood) and working for Norden (part of U. Tech. Corp., don'tcha know) for many years. He married Marjorie in 1950 and has four kids plus four grandkids. Ed has been doing English dances and country dance calling/teaching since 1948, much like my old roomie **Al Little**.—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Our 40th is history, but what history we made! More than 100 classmates and significant others attended the Cambridge events. The names on our badges came from official M.I.T. lists this time, and some people confronted (and scraped off) names they had not used since grammar school. (Sorry . . .) Our class gift of $3,007,201 exceeded our goal and was 30 percent higher than the previous record for a 40th reunion class, according to Reunion Gift Chairman **Harl Aldrich**. However, we are not even halfway to funding our professorship, so work continues on that. Our matching-fund classmate is extending his offer for another year: $1 matching every $2 given toward the chair. Be sure to designate your gift, ""47 professorship." Jackets for sale, hats for sale. We have many extra red nylon snap-front windbreakers with the 40th reunion patch emblazoned in white and white hats with the beaver with slide rule in red. Jackets are S, M, L, and XL, $16 postpaid. Hats run a little small, are $6 postpaid. Write me.

Ah, sweet exhaustion! Born to shop . . . golf . . . tennis. . . sightsee. Manchester Village, Vt., was not founded with all this in mind, but there it is now. Over 60 of us gathered in Vermont at The Equinox, the splendidly restored hotel which dominates the center of the village. Actually, the celebration began on the bus trip up, with **Alex Pastuhov** popping the corks and serving the champagne. Al went on to win in Sunday's tennis tournament. Does anyone else see a connection here?

Hugh Flomenhoft won twice: tennis, and, with wife Lori, celebration of their 38th wedding anniversary. The 12 tennis players included, I am told, three "female ringers"—Lori, Margie (Mrs. **Arthur) Schwartz**, and Kathy Van Greenby. (This did not, however, prevent **Don Van Greenby** from winning the booby prize.) Don fared better as grand marshal for our auto procession up Mt. Equinox. On the way down, we had a good view of the dam designed some 30 years ago by **Harl Aldrich**, here with Lois.

Cars were provided by some from Connecticut

who joined us in Vermont: Madelaine and **John Contegni**; **Dan Carnese**, who brought himself a genuine Vermont garlic press; Evelyn and **Hanford Willard**; and Esme and **Dan Carmody**. Dan was low net in golf. Should I admit that Esme and I, coming back from the shopping area, almost flagged down someone's Winnebago, thinking it was our shuttle bus?

Long drive award in golf went to **Jack Leonard**, whose wonderful sense of humor and witty remarks also enlivened our "M.I.T. College" reunion. Long flight awards might also go to Jack, from Idaho; Lois and **Ken Marshall**, Missouri; Mona and **Gibson Reynolds**, Florida; Sheila and **John Bartelt**, and Arline and **Jim Prigoff**, (great jacuzzi, yes?), California. Artist **Lena Sutera Norman**, Texas, showed us her charming running beavers in bronze (available from Lena and perhaps the M.I.T. Museum shop) for those of us who will not be earning the upright Bronze Beaver.

Also from California are the **Schwartzes (Martin**, with Janet, who entertained us after dinner with her extraordinary miming, and Martie, with **Arthur**, who knew all the words to all the songs we sang that evening). **Parker Symmes**, here with Midge, filled in for the pianist when we graciously allowed him to get some supper (he had played all during dinner upstairs). President **Claude Brenner**, by popular demand, told the Jaguar story, accompanied by some of his diverting poetry.

Other notable after-dinner speakers included **Jordan Baruch** (there with Rhoda), who uninvited, arose to announce that since leaving the government he does not make after-dinner speeches. **Paul Bock**, there with Phoebe, was voted best preserved of the lot of us. (I still suspect that he sent his son.) At our dinner dance Elizabeth and **Francis Schanne** danced every dance. And taping us all in living color were Mary Jane and **John Bender**, who showed us, during cocktails the second evening, what had gone on the evening before. More about the reunion next time.

Some of the excuses for not reuniting with us: **Joe Deal** was planning to be in Europe and **John Kellett** in London for the month of June. . . . **Joe Labov** had two weddings and a cruise this summer. . . . **Thomas Cummings**, a professor at Bradley University in Peoria, was going to Vienna for a year. He has sailed the Atlantic in a 26-foot boat and was sailing to Florida this summer.

Elizabeth and **Laurent Michel** had hoped to come, but they had other committments, etc. He has left engineering and is currently managing director of investment banking at Merrill Lynch. M.I.T. conferred M.I.T. Corporate Leadership Awards on two of our classmates: **John Contegni**, president and chief operating officer, Pavarini Construction Co., Inc., and **John Cowan**, vice-chairman and chief financial officer, UAL, Inc. The award honors exceptional contributors to the continued strength and well-being of the economic system.—**Virginia Carter Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

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Recently M.I.T. conferred M.I.T. Corporate Leadership awards on 64 alumni who are chairmen, vice-chairmen, presidents, or managing partners of leading business, financial, and industrial organizations. These awards go to individuals whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well-being of the economic system. The award was established in 1976, and more than 325 alumni have received the award. Classmates receiving the award, which covered corporate positions held during the period 1984-87, are: **Donald J. Atwood Jr.**, president, GM Hughes Electronics Group; **Vaughn L. Beals, Jr.**, chairman and chief executive officer, Harley-Davidson, Inc.; **Jack A. Belz**, president, Belz Enterprises; **Russell W. Gwillim**, chairman, Safety-Kleen Corp.; **Gilbert V. Rohleder**, chief operating officer, Mapco, Inc.; **George Macomber**, president, George B.H. Macomber Co. (Since receiving the award, George moved from president to chairman of the board.)

Our class had a mini-reunion in June at Ocean Edge in Brewster on Cape Cod. Among those attending were Pauline and **Norbert Andres**, Ginny and **George Clifford**, Gloria and **Sonny Monosson**, Nancy and **Don Noble**, **Bill Hosely**, Jean and **Milton Slade**, Sonia and **Bill Thorbecke**, **Art Fowle** and his wife, Sorina and **Dave Vigoda**, Judy and **Graham Sterling**, Eleanor and **Harold Ottobrini**, Jean and **Bob Turkington**, Tel and **Bob Sandman**, and your secretary. Joining us from the class of '49 were Harry Lambe, Mickey Ligor, and Stan Margolin.

During the day **Norbert Andres** and **Sorina Vigoda** were on the tennis courts for over five hours. Playing together they won the championship of the event. During sunset and with a lovely view of the ocean and the night sky, we had a wine-tasting session followed by dinner. Our thanks to **Harold Ottobrini** for making all the arrangements and acting as host for many facets of the weekend. After Harold's lesson, I enjoyed my first sail on a windsurfer. Following two hours of reaching back and forth along the water's edge, I came in for a delightful lunch overlooking the golf course.

Bill Thorbecke mentioned that he had organized an Enterprise Forum in the Pittsburgh area. . . . Judy and **Graham Sterling** have a new grandson, Arley G. Sterling, IV. . . . **Don Noble** has added contracting of services to his array of products offered for users of heating, ventilation, and air conditioning in commercial and industrial buildings.

Norbert Andres described some work he performed several years ago which was confidential at the time. Singer Corp. made the first dedicated word processor and sold it overseas. Norb was the prime mover on that project, which was performed at an isolated farm to conceal the activity. Memory was achieved using magnetic tape. Following that project, Norb worked on the computer that McDonald's uses for fast food operations. This was another first for business, and again, Norb was the prime contributor. In 1961 **Bob Dean** and a few other Dartmouth engineering professors started the first of several consulting groups and high tech manufacturing companies. By their 25th anniversary in 1986, the various groups had an annual revenue of $26 million and employed 350 people. The largest of these companies is Hypertherm (100 employees), which manufactures a metal cutting torch that uses a water jet to focus the hot gas. The torch produces faster and cleaner cuts than conventional torches.

Creare, Inc., the original consulting group (78 employees), has an annual research contract revenue of $5 million. In 1976, Bob and a few others created Creare Innovations, Inc. to manage the ventures that were closer to manufacturing than to contract research. This group has 42 employees and $1.5 million in revenues. Then, in 1978, Bob spun off Verax, of which he is chairman and director of science and technology. Verax has developed technology for scaling up protein production at low cost. It is still in the venture stage and has attracted large investors because proteins include monoclonal antibodies and interleukens which are considered promising weapons against cancer and other diseases.

He considers himself an early-stage entrepreneur, and he plans to continue his style of moving on to new ventures once the old ones are well established. Bob does not like to manage a lot of people. In May 1987, he started Synoys, a child of Verax, a great-grandchild of Creare, Inc. And in ten years, why not a great-great-grandchild? Bob is not an ivory tower academic, but he maintains a close relationship with Dartmouth College. Its facilities were instrumental in many of the Creare ventures, and he still teaches an occasional course there. His experience includes gas turbines, pumps, plasma-arc devices, rock drilling, heat transfer, total replacement artificial hearts, medical instruments, liquid atomizers, high speed paper drying and automation.

Bob met his wife Nancy at a Wellesley College acquaintance dance when he was a freshman. Their five children include an editor, propulsion engineer, landscape architect, lawyer, and West Point graduate. There are a few grandchildren and more on the way.

George Clifford has formed another company and is introducing a new product. George has added electrical signal processing capability to an IBM personal computer and written a program to record the signal, provide an output signal based on the input signal, and allow transferring the collected data to a spreadsheet program such as Lotus 1-2-3. The output signal can provide continuous control, provide alarms, or abort the run. The input module has voltage and current capabilities to accept signals from pH and ion selective electrodes, thermocouples, and many other transducers. George's initial marketing effort is spearheaded toward chemical applications in research, education, and industry as evidenced by the company name, Computer Chemistry Corp., and the product name, pH by PC.

Related applications include cell biology where a pH electrode can regulate the flow of nutrient and oxygen (air) to maintain a reactor under controlled conditions including maintenance of a preset temperature.

John Twomey was appointed vice president, Operations of C&K Components, Inc. in Newton. He had been production control manager.—**Marty Billet**, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8964

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Two of the most useful and universally used concepts ever developed to assure reliability, safety, and long life in mechanical products of all kinds (airplanes, washing machines, automobiles) have been the bonded resistance strain gage and brittle coatings. Yet, few have ever heard of them. Next year these two landmark ideas will be 50 years old, and **Peter K. Stein** of Phoenix, Ariz., feels that their practically unknown inventors deserve recognition and honor. To that end he is organizing the four technical societies most active in the field for a jubilee session to be held in Portland, Ore., next June. Two of the inventors, Professor Arthur C. Ruge, '33 (strain gages) and Greer Ellis, S.M. '38, (brittle coatings), were at M.I.T., while the third man, Edward E. Simmons, (strain gages) was at Caltech. In Peter's words: "It's time to celebrate the people involved, who deserve our thanks. They should be our heroes. Yet some of them aren't even mentioned in engineering textbooks!"

At M.I.T., Corporate Leadership Awards are conferred on alumni who are chairmen, vice-chairmen, presidents, or managing partners of leading business, financial, and industrial organizations. The award honors individuals whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well-being of the economic system. **Thomas R. Brown, Jr.**, chairman, Burr-Brown Corporation in Tucson, Ariz. and **Michael H. Koerner**, chairman, Suncor, Inc., in Toronto, Canada were among 64 industry leaders who were so honored back in April. Seeing Mike's name in the news release brought back a flood of warm memories because we were friends throughout school. Mike was particularly well-known during his time at Tech for his accomplishments as a classical pianist.

Earl W. Eames, Jr. has been appointed Manager of the Minneapolis Area Office of the international non-profit child assistance agency known as Save the Children Federation. Earl has been an internationalist all his adult life, having served with the United Nations in Africa for eight years, and having held a variety of consulting and teaching assignments both in the United States

and abroad, including Brazil, Denmark, Nigeria, Hong Kong, Japan, the Netherlands, Taiwan and Thailand. Earl and I were particularly close throughout school due to the fact that our names were Eames and Eaton and seating was always alphabetical. He was a most congenial neighbor.

Bob Cowen, science editor for the *Christian Science Monitor*, looked into the future in a disconcerting way recently when he spoke at a colloquium sponsored by The Center for American Studies in his hometown of Concord, Mass. Required by the sponsors to relate his presentation to Concord, he took as his theme the town dump. "Our little sanitary landfill here is quietly producing methane, or marsh gas, among other things," said Bob, "and while we don't give it much thought, it has an impact on the world." He went on to say that man is causing significant environmental changes and that "collectively, we've become a force of nature with the same order of impact as a tornado or volcano but we do not fully understand this impact." Bob predicted that environmental factors would lead to unprecedented "bending" by major powers, changes in the relationships between nations, and a challenge to the concept of sovereignty.

As I write we are about two years away from our 40th reunion. Even so, a committee has been working hard for a long time on this event. The most recent meeting was on June 29 at which time it was decided that we will stay at the Marriott in Kendall Square for the on-campus portion of the festivities (Wednesday, Thursday, and Friday of whatever week it turns out to be). The class banquet will be held on Wednesday evening but where we go and what we do for Saturday and Sunday is the subject of much deep thought.—**Fletcher Eaton**, Secretary, 42 Perry Dr., Needham, MA 02192; (617) 449-1614

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Will F. Nicholson, Jr., MG; 15 SB, chairman of the board and president of the Colorado National Bankshares, Inc., was among the recipients of the M.I.T. Corporate Leadership Awards, conferred by M.I.T. upon 64 of its alumni whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well-being of the economic system. Dr. David Saxon, chairman of the M.I.T. Corporation, presided at a corporate luncheon at which the awards were presented. M.I.T. established the awards in 1976 and, since then, more than 325 alumni have been the recipients.

In March, Dr. **Robert A. Pucel**, consulting scientist of the research division at Raytheon, lectured on monolithic microwave integrated circuits, at Lexington, Mass. Dr. Pucel, a fellow of the IEEE, is a co-recipient of the 1976 Microwave Prize of the MTT Society. He was the National Lecturer of the MTT Society in 1980-81 on the topic of MMICs and is the editor of the recent IEEE/MTT reprint entitled "Monolithic Microwave Integrated Circuits."

Karol A. Stark informs us that he is making regular business trips to North and south Carolina. He has a second home, in Durham, N.C., his first is in Barneveld, N.Y. Karol says his family is now streamlined to his wife, Deborah and his son, James—all others are out of the nest.

In 1979, Fletcher L. Bartholomew founded the Information Institute for Publishing and Consulting. His first major work, "Iconoclasm: The Way Out of the High Technology Dark Age" was released in June of this year. . . . Sidney Topol is presently chairman of Scientific-Atlanta Inc. located in Atlanta, Ga.

We regret to announce the death of **Herbert F. Ayres** who died on May 8 of this year after a long illness. The eulogy was delivered by his long time friend, **Arthur S. Chivers**, class of '52. . . . **John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

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Each year M.I.T. confers corporate leadership awards to 64 of its alumni who have served in major roles within their organizations. Two of our classmates were honored this year. The recipients are **John L. Roper** and **Albert L. Zesiger**. John is chairman of the board and CEO of the Norfolk Shipbuilding and Drydock Corp. Albert is the president of BEA Associates, Inc. Allow me to express the congratulations of our class to both of these gentlemen.

A feasibility study and business plan prepared by **Gerald B. Levine** to have California enter into activities promoting its exports has been accepted by their governor and legislature. Offices have been opened in London and Tokyo. . . . Professor **George Field** has served as a member of the National Commission on Space during their 1985-1986 term. . . . The IPO, Inc., a nonprofit association representing patent holders has conferred their Inventor of the Year award to **Amar G. Bose** for his Bose Acoustic Wave Music System. Dr. Bose heads his own corporation and has been working in sound systems since the early fifties.

The Spire Corp., a manufacturer of complex semiconductor and optoelectronic materials, has appointed **Carl N. Graf** to its board of directors. Mr. Graf recently retired as president and CEO of W.R. Grace & Co. after having served as president from 1981 to 1986. . . . After 32 years with the Hurst-Rosche, Inc. Consulting Engineers, **David Rowe** writes that he is still in the consulting engineering business. He is also president of Atlas Soils, inc. and is serving as chairman of a hospital board. . . . Living in Fairfax, Va., **Henry Hahn** and his wife Marilyn have two children and two grandchildren. Henry is the board chairman and CEO of the Artech Corp., the major materials and R&D testing laboratory in the metropolitan Washington area. Henry feels that their greatest success has been in the area of orthopedic and dental implants.

Regretfully, I have to relate the death of **Bruce C. Center** last March. His family sent me a lovely note about him. Following graduation from Course II, Bruce worked for five years with International Harvester prior to returning East to join the Raytheon Co. He was a principal engineer and a major contributor to their Missile Systems Division. He was their Patriot missile randome expert and was sought after for his outstanding analytical abilities. Bruce was a respected contract bridge player and a prize-winning photographer. He and his wife Cathryn considered their four children and one granddaughter their happiest achievements. Let me express our condolences to his wife and family. They wrote of how much they miss his integrity, wit, intelligence, and love.

Sadly, I also received word of the passing of **Prokopis H. Barrows** in May. He was an electrical engineer with the Jackson Co. of Boston and was also a lawyer. Our condolences are expressed to their families.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

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As the penultimate act of his term of office, **Art Turner** sent along the following:

"The 35th Reunion is a thing of the past! We all had a very good time, albeit a chilly one. Driving down on Friday afternoon we were about five miles away when the sun disappeared in a fog bank. It was in there most of the time, but not all. We had sun for the tour of Newport and for shopping in the middle of the day. Belcourt Castle was the great house that we visited on the tour.

"The Marble House dinner and dance was a pleasant time for all and was certainly the high spot of the weekend. We had a bit of confusion with the class picture—too little space on the grand stairway for the wives and classmates at the same time—and no easy way to name those present, but the banquet was memorable and the dancing excellent.

"Cold it is at the North Pole, but the coldness does not compare favorably with Newport Harbor after sundown. After a loop around the harbor, we came back to the dock to get hot coffee, and quite a few jumped ship and went running for the heat of the Sheraton Islander. The rest of us had a great time! You should have been there!"

The business of the reunion, apart from having a good time, was electing class officers for the next five years. **Dick Heitman**, who was reunion chairman, replaces Art as president, **Stan Sydney** continues as treasurer, I continue as secretary, and **Bob Lurie** had the big job of 40th reunion chairman. Planning for the 40th started immediately after the 35th ended. I am informed that we, too, should start budgeting for it.

Swraj Paul, chairman of Caparo Group, Ltd., was among 64 alumni honored by M.I.T. with Corporate Leadership Awards last April for being corporate leaders, apparently in the belief that such people are especially in need of encouragement, or perhaps because it never hurts to be nice to the boss. 325 alumni have received the award since 1976.—**Richard F. Lacey**, Secretary, 2340 Cowper Street, Palo Alto, CA 94301

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Campbell Soup Co. has named **Dan Farkas** vice-president of process research and development at the Campbell Institute for Research and Technology, in New Jersey. Dan is directing a research and development program aimed at developing processes for high quality food products that are distinct from the company's competition. Before joining Campbell, he was chairman and professor of food science at the University of Delaware. He has worked with Arthur D. Little, Inc., and with the U.S. Department of Agriculture. He, his wife Alice, and their two children live in Maple Shade, N.J.

Paul Drouilhet has been given a Fellow Award from the Institute of Electrical and Electronic Engineers for his leadership in developing the Discrete Address Beacon System. Paul is assistant director of the M.I.T. Lincoln Laboratory. . . . **Harry Faulkner** was among 64 alumni honored last April by M.I.T. for distinguished corporate leadership. Harry is president and chief executive officer of Alfa-Laval AB in Sweden. . . . and **Paul Gray**, who manages to keep busy, has been re-elected to the governing council of the National Academy of Engineering.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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As you read about the M.I.T. Commencement, Technology Day and class reunions in other parts of this month's *Technology Review*, you should be aware that the class of '55 was represented in the second balcony at "Tech Night at Pops." Jan and **Ed Ehrlich** and Edie and **Bob Greene** had a fine dinner at Legal Seafoods (the Ehrlichs are still in a state of shock over the numberous changes in the Kendall Square area) and then topped off a delightful evening with John Williams, guest soloist Frederica Von Stade, the Boston Pops Orchestra and a rousing chorus of "Arise! All ye of M.I.T." **Frank Perkins** and his wife, Gerry, were observed with the VIP's on the main floor and we expect other classmates may have been there as well.

This is becoming a regular annual event for the Greenes and Ehrlichs. If others would like to join us at the Pops, just get in touch with either of us a month or so in advance and we'll arrange for a block of tickets.

Tony Merz reports that, "I have stayed in northern California since I got my Ph.D. from Stanford in Aero/Astro in 1970. Several small

companies preceded my most recent six years with Lockheed Research Labs in Palo Alto. My technical work centers on computer analysis and simulation of dynamic systems, as befits somebody from Course 16. I'm still using my bike daily for the eight-mile commute to work, but I'm currently recovering from a broken thumb acquired on one of those trips. My wife Peggy has been successful with her silk screen business, and two daughters are juniors in high school and college. I would be happy to hear from any classmates passing through the Stanford area. Incidentally, many recent M.I.T. graduates have high visibility in Lockheed, and they seem to know everything I knew as a graduate, plus three decades of additional accumulated stuff. How is this possible?"

We have learned that **Bernhardt J. Wuensch** received the 1987 Outstanding Educator in Ceramic Engineering Award. Sponsored by the Ceramic Education Council of the American Ceramic Society, the award was established to recognize truly outstanding work and creativity in teaching, in directing student research, or in the general educational process (lectures, publications, etc.) of ceramic educators. Presentation of the award took place during the CEC business meeting on April 26, in Pittsburg. Dr. Wuensch is professor of ceramics and TDK Chair of Materials and Science and Engineering at M.I.T. He lives in Concord with his wife, Mary Jane, who works at the Concord Public Library and does free-lance art work for ACT/TUNES Youth Theater in Concord. Their son Stefan just graduated from high school and will attend Brandeis University in the fall. Katrina is 15, in high school.

We regret to report the death of **Arthur C.E. Oberton** of Riverside, R.I., April 1986. Our sincere sympathies to his family.

Please keep the information flowing.— **Robert P. Greene**, Co-secretary, 37 Great Rock Road, Sherborn, MA 01770; and **DuWayne J. Peterson, Jr.**, Co-secretary, 201 E. 79th Street, New York, NY 10021

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Stanley Kroder writes that he is still with IBM in Dallas as manager of telecommunications education and interactive satellite video education broadcasting. He recently joined the University of Dallas as adjunct professor in the M.B.A. program.

Bill Salmon retired from the U.S. Department of State on January 31, 1986, and became the executive officer of the National Academy of Engineering. The NAE was founded in 1964 and shares a congressional charter with the National Academy of Sciences. Bill says that work after retirement is acceptable with three teenage children.

Linda and **John Decker** still live on Maui and are looking forward to their 29th wedding anniversary this year. Their daughter Sarah is now a sophomore at University of Southern Califiifornia in Los Angeles and thinking of majoring in business. John writes: "I'm still splitting my time between consulting (new venture analysis) and running my own very small company, Kuau Technology, Ltd., with the balance shifting to Kuau Technology now that our two main projects (an automatic sextant for marine navigation and a weatherproof, graphite-epoxy classical guitar) are both nearing market introduction at once! The guitar project, which involved working with a master guitar maker (luthier) in Albuquerque and a resins-and-fibers wizard here on Maui, has been a particular satisfaction, and it is doubly so now that it WORKS, producing GOOD sound (after all the 'dang fool CRAZY idea' comments early on!).

Bill Hooper writes from Atlanta, Ga., that he remarried three years ago and now has a teenage son and daughter and a teenage stepson and stepdaughter. Bill's daughter is a sophomore at Harvard. Bill keeps busy with sailing (picked up a few racing trophies), bicycling (recently finished a 600-mile bike tour of northern California), and learning to use a potter's wheel.

Robert Rosenbaum, formerly senior systems engineer, Federal Systems Division of the IBM Corp., is now international vice-president of Xyplex, Inc. of Concord, Mass.

Alex Bernhard reports that as a result of having the good taste last November to marry Myra Mayman, director of the Office of Arts at Harvard and Radcliffe and Master of Cabot House, he is now the associate master of Harvard's Cabot House. Alex adds that he remains a full-time partner at Hale and Dorr in Boston practicing corporate law.—**Vivian Warren**, Secretary, Anasville Rd., Somers, NY 10589

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Fall is here and the 30th reunion is only two seasons away. So, be sure you're planning now for the great festivities including sailing, swimming, "masters level" sporting events, and seafood aplenty!

Among the recipients of the M.I.T. Corporate Leadership Awards was **Leonard Simon**, chairman of the board and chief executive officer of Rochester Community Savings Bank. This award honors individuals whose responsibilities in private industry mark them as an exceptional contributor to the continued strength and well-being of the economic system.

Herbert Sobel is currently Manager of Advanced Computer Programs in the Electro Optics and Strategic Systems Directorate at Raytheon Missile Systems Division. Herb has also had considerable technical and general management experience with commercial companies and held successive positions as vice president of Engineering at Analogic, Kodak-Atex, and Kontron Medical.

We received a letter from **Eugene Zuch** in which he writes, "I am presently director of Corporate Marketing for Computer Products, Inc., a $100 million electronics company located in Pompano Beach, Fla. The company is an up and coming producer of power supplies (#2 in the U.S.) and measurement and control systems." Our mailbag also contained a note from **Art Alexander** telling us that "after eight years as associate head of the economic department at the Rand Corp. I have now, as they say, returned to full-time research—not that I can notice much difference. I am focusing on R&D in non-market institutions. My research covers such areas as Soviet and Chinese defense R&D, U.S. weapons acquisition, and energy policy. Our eldest child, Sarah, is heading off for U.C. Santa Cruz, which is about as different from M.I.T. as it's possible to get. I am serving on the M.I.T. educational council interviewing local high school students, some of whom are quite outstanding. Also, just finished my fourth marathon and aiming for number five shortly."

A brief note arrived from **Leon Abulafia**, who started with the class of '58, in which he brings us up to date on his activities. He writes that "I retired from M.I.T. last fall. And last June, thanks to the M.I.T. Chapel and the combined efforts of several staff members and fellow '58 classmates **Bill Jordon**, **Sig Silber**, **Bob Arzt** and **Mannie Landsmen**, I was launched on the seas of matrimony (maiden voyage!). Jeannette and I live happily in Millis, Mass., a small farming community. I've teamed with two partners in a small consulting engineering business. So far, it's non-profit but we expect to turn that around soon."

You'll notice at the bottom of this column that your secretary has a new address in Wisconsin. Nancy and I have moved to Madison, where I have accepted a position as chairman and chief executive officer of Madison-Kipp Products Corp. This company is a subsidiary of Madison-Kipp Corp. and our division manufactures automated lubrication systems for conveyor lines and industrial machinery. At the same time, I continue to serve my former company, Technology Consulting Group, Inc., as chairman of the board. We have appointed a new president and chief executive officer to direct the future growth of TCG's management consulting services for U.S. and international firms. By the way, Nancy and I have finally abandoned apartment living in favor of a house and we have lots of room for visiting classmates. Come on out and tailgate with us at the Big Ten football game!—**Michael E. Brose**, Secretary, 841 Magdeline Dr., Madison, WI 53704

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Ken Dreider is group leader for Solid State Sensors in the Center for Chemical Engineering at NBS. Last year he developed a sputtering process to make icosahedral quasicrystals. (It's refreshing to see one of our Course III classmates using the knowledge we learned at the feet of Professors Backofen, Cohen, Grant et al.) Ken's son Brett obtained his S.B. in electrical engineering at the Institute in 1986. . . . The good Reverend **Clifford Benzel** has recently become president of Dove Associate International, an appropriately named humanitarian agency concerned with the poor in the Third World. . . . **Joe Kubis**, in a beautifully scribed calligraphic note, notifies us that he joined the Computer Aided Engineering Department at the Ford Scientific Research Laboratories in Dearborn, Mich. His work entails writing software for complex scientific and engineering problems, and he is currently engaged in optic ray tracing for automotive lamp design.

Bill Towle is still working with information systems at WHO in Bremblens, Switzerland, and enjoying the Swiss Alps. Son Andrew is a junior at Tufts, while son Steven is in Course III and XIV at the Institute. His wife Faith is an editor/librarian at IMEDE, while Bill stays active as secretary of the M.I.T. Club of Switzerland. . . . **Jim Herring** has been appointed associate director of the Budd Co.'s Technical Center in Auburn Hills, Mich. Jim joined Budd upon graduation and was most recently manager of engineering and computer science for the automotive industry supplier. . . . **Bob Polutchko** writes, "Regards to all from Potomac, Md. Son Bob has stayed at M.I.T. at Draper Labs and Course XVI grad school. Daughter Diane has graduated from Boston College; daughter Carol is at Colorado State; and daughter Karla starts college this year. Life sure moves on!"

Governor Michael Dukakis has appointed **G. Richard Huguenin** to the board of trustees of the University of Massachusetts. Richard, a physicist at M.I.T., is the founder and CEO of Millitech Corp. Before starting Millitech he was a member of the faculty at Harvard, where he received his Ph.D. in astronomy. M.I.T. honored several senior executives last spring. Receiving Corporate Leadership Awards from Paul Gray, '54, and David Sahon, '41, were **Walt Humann**, chairman and CEO of Hunt Oil Co.; **Pat McGovern**, chairman and CEO of International Data Group; and **John Poduska**, chairman of Apollo Computer. These awards were established by the Institute in 1976 to recognize distinguished corporate leadership by M.I.T. alumni; 325 have been honored thus far.

Speaking of **Walt Humann**, he was feted by his fellow Texans as well. Walt was presented a special community service award by the Texas Society of Professional Engineers for his long-standing commitment toward improving the quality of public transporation in Dallas County. The award is an extremely prestigious one conferred only once before in 1981. . . . **Pat McGovern** has just funded a professorship in management information systems at the Sloan School. Says Pat, "My days and nights at the M.I.T. Computation Center, combined with my writing-to-deadline experience at The Tech, gave me the inspiration, and made me familiar with the dedication needed to keep on the leading edge of information flow."

Nam Suh, presently on leave from the faculty of the Institute to serve as assistant director of the

Messages Behind the Dreams:
Jungian Analyst Funkhouser, '62, Shares Experience

A man dreams he is in an elevator, and the floor is tipped. What is this dream telling him? If something about his life is lopsided, his unconscious might be trying to get the message through—stay in balance. One must consider a number of factors when deciphering such messages, says Art Funkhouser, '62, who shared his knowledge and experience as a dream analyst with about 35 classmates as a special feature of their 25th reunion last June.

Contrary to Freud's theory that certain symbols always mean certain things, Funkhouser says one needs to ask people what particular symbols mean to them. For example, when an individual dreams of a horse, the analyst might ask about the color, size, and whether or not the person has ever seen a horse like that. One who's been bitten by a horse as a child will have totally different feelings associated with horses than one who enjoys riding them frequently, he points out.

It's important to consider the situation in which a dream arose—what was going on that day, who the dreamer was dealing with, what sorts of issues had to be faced. The analyst also wants to know the tone of the dream ("How did you feel in that situation?"), asks Funkhouser, for very often it's in the feeling that you find the dream's message.

Dreams say exactly what they mean, Jung contended; it's just that the language is not our normal language. Dreamer and analyst have to wrestle with the symbols. When a person chews on a dream over a period of time, often new knowledge from the unconscious will surface days and weeks afterwards, says Funkhouser. And, there's a self-corrective function—the unconscious will complain if it's being misread. It's also important to know that the unconscious often exaggerates. For instance, says Funkhouser, "You might think it would simply say, 'Why don't you write a letter to so and so?'—instead it says, 'So and so *died*!' "

Funkhouser's talk inspired a lively question and answer period afterward. A sampling follows:

Q: As a therapist, what kinds of problems do you solve by going through dream interpretation?
A: Certain types of depression, for example, as well as most neurotic problems. Mid-life crises are also amenable to such an approach. As dream analysts, we don't have a lot of luck with heavy psychosis, where the ego boundaries to the unconscious have been knocked over and the consciousness is too flooded with material from the uncon-

NSF, was chosen to become a fellow of the American Society of Mechanical Engineers. . . . **Kent Kresa** moves upward to become the president and CEO of Northrup Corp. in Los Angeles. . . . **Carl Poedtke** is now a director of the Institute of Management Consultants. Living in Lake Forest, Ill., Carl is a partner at Price Waterhouse ("the envelope, please"). . . . **John Schindler** is now the secretary-treasurer of the IEEE executive committee in Boston. John works at Hanscom AFB as chief of the antennas and components division there.

Some of you took the time to drop a line, so let's finish up with those. **Emile Battat** writes: "After nine years of commuting to midtown Manhattan, my office finally relocated to Stamford, Conn., a 15-minute easy drive. I now have extra time to exercise each morning, and the day starts in a very leisurely fashion. The downside—I am less well informed since I no longer read the *New York Times* cover to cover on the train!" . . . **Paul Brown** reports that during the latter part of 1986 he was the Energy Department delegate to the Nuclear Test Experts' Meetings in Geneva. He explains that these are bilateral meetings between the U.S. and U.S.S.R. to discuss a broad range of issues regarding nuclear testing. Paul serves as assistant associate director for arms control at the Lawrence Livermore Lab.

Stephen Kaye reports that for the past 25 years he has been working in consumer products (marketing and advertising). He's president of his own company which does new product consulting—on the beach in Westport, Conn. . . . **Bob McAuliffe** writes that he's been pretty busy with M.I.T. affairs as president of the Northern New Jersey regional club. A highlight of this year's activities was a visit by Paul Gray, '54, who hails from that area. Paul described a typical day in the life of M.I.T.'s president. Bob was recently "head hunted " to a new position with Cadillac Fairview, an industrial development firm in Saddle Brook, N.J. As a vice-president there he spends most of his time acquiring industrial properties anywhere within two hours of New York City.

And now for the nostalgia phrase of the month: "Log Log Duplex Decitrig." Does anyone still use one?

I, **Art Collias** recently made one of my increasingly infrequent trips to Kendall Square. It is almost unrecognizeable with all the new buildings and construction going on. (See July, pp. M.I.T. 4-9.) One landmark is gone: the F&T Deli closed after over 50 years in business, Messers. Fox and Tishman giving in to the enticements of the developers. There are two new noteworthy additions: a newly-opened and very spiffy branch of The Coop and an always-crowded-but-worth-waiting for branch of Legal Seafoods. For those of you who have not been back to the Boston area in some time, this would be an ideal time for such a trip. Boston and Cambridge are alive, exciting, and worth seeing. If you can't make it this year, start making plans to attend our 30th reunion. It's less than two years away!—Co-secretaries: **Ron Stone**, 116 Highgate Place, Ithaca, NY 14850 (607) 257-2249; **Art Collias**, 24 Hemlock Dr., Canton, MA 02021, (617) 828-5073

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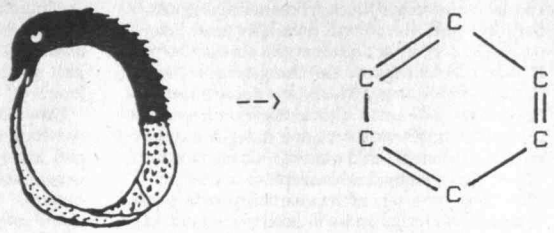
David Bushnell of Palo Alto, Calif., recently had a new book published: *Computerized Buckling of Shells*. . . . **Sherman Karp** does consulting work

ILLUSTRATION: JON MCINTOSH



German chemist Frederick Kekulé got help from his unconscious while attempting to solve the chemistry of benzene. One night he dreamed of a snake biting his tail, leading Kekulé to benzene's ring structure.

scious to digest it. We're grateful to psychiatrists who can damper this situation, and then it's helpful to look at the material brought from dreams.

Q: Do you recommend drugs as a means of getting information from the unconscious?
A: I think drugs are rather a crowbar approach to the unconscious, a barging in without observing the necessary preliminaries. It's better, in our experience, to let dreams bring out whatever the unconscious wants to say at its own pace. Although many new drugs are now being tested, the results are unknown.

The unconscious seems to respond best when it's treated with respect. Some go at it like they were fishing—with an alarm clock that wakes them up every hour. The alarm often knocks all memory out the window. A pad and pencil beside the bed to write down the dream upon awaking is more effective.

Q: What does it mean to have a good dream or a bad dream?
A: Good and bad is our reaction to it, not the dream itself. A dream is like a photograph from the unconscious; pleasing and unpleasant aspects often comingle. If we ignore one or the other, we miss half the dream.

Q: Why do people sometimes wake up very suddenly at a crucial period within the dream? Is it something the person is unwilling to face? Or do we tend to remember the dream when we wake up suddenly?
A: In my experience, the dreams I've been jolted awake from are the ones I really needed to pay attention to. Sometimes people exit from nightmares when the going gets too heavy. Occasionally, people have been known to not quite wake up: they get stuck; their bodies are still paralyzed, but their minds are awake. It's terrifying to find that for several seconds they can't move at all, until they find a little finger or something that will move.

Q: Do most symbols in dreams mean something, or does one have to allow for some randomness? Are some symbols just noise?
A: We're just not used to the language. With increased time and working at learning to understand, a dialogue develops. Often what we thought was just noise were things to which we didn't yet have a clue.

Q: Do people who are multilingual always dream in one language?
A: I'm bilingual. The dreams I dream in Swiss-German can only be expressed in Swiss-German. I had a Turkish exchange student who felt that when he began dreaming in English he knew he was beginning to feel comfortable here.

Q: What's going on when people have the same dream? Is it coincidental or something about shared consciousness?
A: There have been several reported incidences of fathers and sons having the same dream. There are also cases reported in which therapists and their patients have had the same dream, which shows they're really engaged.

Dr. Funkhouser is collecting material for a book he is preparing about deja vu. Anyone who would care to describe and answer questions about his/her experiences can obtain a questionnaire by writing him in care of 9639 Cold Star Court, Columbia, MD 21046.—*Sandra Knight*□

and lives in Potomac, Md. . . . **Marc S. Weiss** has been recently promoted to head the Impact Sciences Program and Department at the Naval Biodynamics Laboratory in New Orleans. . . . **Dick Oeler** is vice-president and general manager of the Process Gas and Equipment Division of Air Products and Chemicals, Inc., in Pennsylvania. Dick reports that he and Elaine are doing real well, and one son is at Williams while the other enters the University of Massachusetts in September.

Susan E. Schur is publisher and editor of *Technology and Conservation of Art, Architecture, and Antiquities* and is president of her own advertising agency. She recently received an award from the Boston Society of Architects for her work in the areas of technology and conservation. She is described as an "untiring artist and writer, organizer and publisher, whose pioneering journal *Technology and Conservation* is a uniquely informative resource for preservationists everywhere." . . . **Larry Elman** reports from Grumman on Long Island, where he works in the Operations Analysis Division, that he is also active in the Air Force Reserve as colonel and is now assigned on the military staff of the secretary of the Air Force. On the home front, he has been awarded custody of his two children, which is something he's been working onf for quite a while. . . . **John W. Norris**, president and chief executive officer of Lennox Industries, has been awarded the M.I.T. Distinguished Corporate Leadership award.

It's been my pleasure serving as class secretary, but due to other demands I am resigning from this position as of this issue. I would like to welcome **Frank Tapparo** as the new class secretary. Please send all notes to him at 15 S. Montague, Arlington, VA 22204.—**E. Patrick Coady**, Secretary, c/o The Acacia Group, 51 Louisiana Ave., N.W., Washington, DC 20001

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Henri Schnurmann was promoted to senior technical staff member at IBM at their East Fishkill facility in New York. This is Henri's 24th year at IBM—the last 15 in the same place. He points out that this record doesn't square with IBM's reputation as "*I've Been Moved*" type of place. IBM seems to like him. They say that the promotion recognizes "distinguished and sustained technical achievement." Henri's expertise is in the VLSI testing line. The Schnurmann's live in Monsey, N.Y. Their kids are well spread out, with the oldest a teacher in one of the local schools, the next in high school and the last (David) in fourth grade. Henri recalls that our tuition was $800 and wonders how many people in our class can afford to send their kids to Tech these days.

Ken Scott came across an article in the *New York Times* (February 22) that mentioned **Harvey Lunch** works at the Stanford Center for International Security and Arms Control. The front page article dealt with the possibility of using SDI weapons for offensive purposes and quoted Harvey as saying, "If the Soviets decided to deploy such a thing, people like Casper Weinberger would be having fits."

Harry Baya writes, "I'm still in Hastings-on-Hudson, working in Pascal on micro-computers. I am hoping to get involved with the new micros (Mac-2 and IBM-386) as teaching aids. . . . **Bill Jouris** writes, "We have returned, at last, to the Boston area and our beloved home in Littleton,

Mass. I started work in September at Lincoln Laboratory thanks to the efforts of another classmate, Dr. **Richard "Punch" Williamson**, who is a group leader here. We are hoping not to have to move again in the near future. The twins are now in high school." **Pete Gaposchkin** writes that he is working for the Bureau of Management Information Systems in the city of San Francisco as a programmer analyst. He's been there since 1984.

Thanks for the letters everyone and keep 'em coming.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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If you missed the 25th reunion, you missed a great time. It began on Thursday, June 4, with a night at the Pops—a treat that most of us remember from our days at the Institute as "Tech Nite at the Pops." The only real changes were the words of the (unofficial) alma mater, now "Arise All Ye of M.I.T.," appropriately altered with respect to the growing number of women students, now about 35% of each entering class. **Marilyn (Arsey) Bever** (a.k.a. "Buz") served on our reunion committee, and **Steve** and **Emma (Marcia Arentzen) Root** attended the reunion but we missed our other women classmates at the reunion events.

Friday was Technology Day, with programs about education and research at M.I.T., principally focusing on the use of the computer network, Project Athena. The class photo session on Friday afternoon brought together the largest gathering of classmates, about 126, and most of us basked in the bright sunshine and reminisced until the buses took us to a reception at M.I.T. President Paul Gray's home and then to the Boston Museum of Fine Arts. The Friday evening events were especially enjoyable as we sat in the **William I. Koch** Tapestry Room and listened to an excellent musical performance by **Lane Anderson**, premier violoncelle-solo with the Orchestre Philarmonique de Monte Carlo, Monaco. Lane was ably accompanied on piano by Mark Ryser, a graduate student at M.I.T. born in 1962. The dinner was poached salmon, with wine from Dry Creek Vineyards provided by vintner **Dave Stare**. We enjoyed Dave's wine at Friday and Saturday evening events, and each classmate in attendance at the brunch/class meeting on Sunday received a specially labeled bottle of Dry Creek Vineyards 1984 Sonoma County Cabernet Sauvignon as a remembrance of our 25th reunion. The dinner on Friday night included an excellent slide and talk show by **Mead Wyman**, ably assisted by **Tom Gretak**, professor of physics at M.I.T., **Mitch Maidique**, president of Florida International University in Miami, **Dave Koch**, executive vice-president for Chemical Technology at Koch Industries and 1980 Libertarian candidate for vice-president of the U.S., and **Scott Burns**, syndicated financial columnist for the *Dallas Morning News*.

Saturday morning, we celebrated the measurement of the Harvard Bridge in units of **Oliver R. Smoot**, and found that the bridge has gotten shorter since it was originally measured in October 1958, at 364.40 + one ear, as part of Ollie's initiation into the M.I.T. chapter of Lamda Chi Alpha. We had a short, police-escorted parade of late-1950s vintage cars (including **Jan Hyde** in his classic Corvette) across the bridge and presented the M.D.C. and Ollie Smoot with plaques to commemorate the event. One of the plaques is to be placed on the bridge when renovations have been completed, and until then it will be in the safekeeping of Warren Seamans, director of the M.I.T. Museum. Saturday afternoon included a presentation by **Art Funkhouser** of Bern, Switzerland, on Jungian psychotherapy, and a brief discussion on deja vu and related E.S.P. experiences. While there were skeptics in the audience, 80% of those in attendance claimed to have had some form of E.S.P. experience. There was also a special gathering for participants and friends of M.I.T. Athletics with Royce Flippen, director, Jack Barry, assistant director (and former coach of the 1962 basketball and baseball teams), and John "Murph" Murphy, equipment manager. It was a special occasion for those who attended since both Jack and Murph will retire this year. Saturday night we had a dinner at the spectacular John F. Kennedy Library, on the Dorchester side of Boston Harbor. **Tony Mack** introduced **Marty Klein**, who presented a slide show on his adventures with side-look submarine radar and discoveries of shipwrecks and searches for sea monsters. While Marty seemed a bit skeptical about the Loch Ness monster, he has participated in scientific searches for it, and will be checking out Lake Champlain for a similar creature in the near future.

Sunday, June 7, we had a wonderful brunch at the Cambridge Marriott, a development project of classmate **Ed Linde** and some of his business associates. **Mead Wyman** reviewed the results of the questionnaire and found that respondents were mostly happily married to their first wives, had 2.6 children, and lived in the suburbs. While we believed in atomic theory and thermodynamics, most of us were skeptical about acupuncture, astrology, fortune cards, ghosts, mental telepathy, U.F.O.s, water divining, E.S.P., palmistry, and the Strategic Defense Initiative. We weren't sure about faith healing, free will, hypnosis, infinite universe, chiropractic, or psychoanalysis, and most of us did not even know what homeopathy was. (It's a system of medical treatment based on the theory that certain diseases can be cured with small doses of drugs which in a healthy person and in large doses would produce symptoms like those of the disease.) We also chose new class officers: After 25 years at the helm, **Bard (Bojey) Salmon** has turned over the wheel to **G. Mead Wyman**, our new class president. **Tony Mack** will serve as treasurer, and yours truly, **Hank McCarl**, will now gather data for this column as secretary. Twisting arms to fill these positions was **Fran Berlandi**, who chaired the nominating committee.

Those in attendance seemed genuinely pleased with the events of the reunion weekend, and most of us went home to await the arrival of our giant M.I.T. Class of 1962 ring replica paperweights that didn't get out of the foundry in time for us to lug around at the reunion. More fun things about classmates will be printed in this column from the questionnaires in the months ahead.—**Hank McCarl**, c/o McCarl and Associates, P.O. Box 352, Birmingham, AL 35201

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We begin this issue's notes with kudos for several of our classmates. First, on April 24th the Institute conferred M.I.T. Corporate Leadership Awards on 64 graduates. "In doing so, the Corporation symbolically expresses its esteem and abiding appreciation to M.I.T. alumni everywhere, who further the public interest daily through exemplary conduct of corporate enterprise." Among the recipients was our own **Steve Kaufman**, who is president and CEO of Arrow Electronics. Congratulations, Steve. You are among illustrious company, including the inventor of Ethernet, the founders of Lotus Development and of Kaypro, and the chairmen of Tandem and Apollo Computer Companies.

An award of great distinction also went to **Alexander Levis**, from the IEEE of which Alex is now a fellow. And **Bobby Goode** reports that Sigma Xi, the Scientific Research Society, selected him from among 2,500 nominees as one of four outstanding science teachers in New Jersey. Former astronaut Dr. Sally Ride presented the award.

The *New York Times* reports that **Jon Clemens** is now president and C.O.O. of Chronar Corp. of Princeton, N.J. Jon was formerly a staff VP at RCA Laboratories. (I wish you folks would take a moment to report your successes directly to me; it's expensive to buy the New York Times down here in Baltimore.)

I have a note from **Paul Milner**, who is living in Sharon, Mass., and who is a research and clinical audiologist at the Massachusetts Eye and Ear Infirmary in Boston. **Tom Sheriff** reports that he and his wife Sylvia were to have participated this past summer in an archeologica dig at Caesorea, Israel.

David Marks has been substitute teaching, at two local high schools a couple of days a week, and urges classmates to do the same. "It's a great experience." Dave has developed a "sinusoidal camera," for which he is seeking projects. The frame-rate varies conforming to a sine wave, and the operator can control the peak (min and max) durations. The system is computer controlled. He has also almost completed a concrete house which he began building five years ago.

It's time to start gently reminding you all about our 25th class reunion, coming up next June. President **Jack Lynch** sent out a mailer about this in early June. If you haven't gotten a copy please call the Alumni Association office at M.I.T. If you've received the material, and haven't sent in the deposit, or haven't started calling classmates, you are on warning. Let's get together next Spring and have a great time swapping yarns, relating our successes in life, supressing our failures, and drinking our brains out.—**Phil Marcus**, Secretary, 2617 Guilford Avenue, Baltimore, MD 21218, (301) 889-3890

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As you read this, recall that 25 years ago most of us were busy as juniors at M.I.T. My recollections are of lab and project courses that had gotten much more challenging, of preparing to be hosts rather than victims at Field Day and of starting to think about what I was really going to do with the education that was being (sometimes painfully) acquired. The real world was intruding; most if not all of us were carefully monitoring the events of the Cuban missile crisis. And to think, there were few Boston radio stations that stayed on-air all night.

John Meriwether writes from Ypsilanti, Mich. that he is looking for a teaching position in the Boston area. After eight years at Michigan, he decided it's time for a change. John's son Alexander is 6 years old, has started school and is already doing work on the MacIntosh. John hopes that he'll want to go to M.I.T. . . . The latest **Al Teich** book is out. It is *Science and Technology in the USA* (London: Longman's, 1986) written with Jill H. Pace and others. It is Volume five in the series *World Guide to Science and Technology*..

Roger Lewis has had a year full of accomplishments. He was promoted to Professor at the University of Maryland and advanced to the College of Fellows of the American Institute of Architects. Roger received an AIA/*Washingtonian* magazine award for residential design and an American Association of University Women award for "Shaping the City", his column which appears weekly in the *Washington Post*." A collection of the column was published by the AIA Press in March.

Robert Fischer has been promoted to division chief, strategic affairs, in the Strategic Programs Bureau of the U.S. Arms Control and Disarmament Agency. He is living in McLean, Va. . . . **David Morrison** sold both of his businesses in 1986 and took 4 months off, his first vacation in 7 years. He is presently employed by Undermountain Truck Sales in Hancock, Mass.—"a town so small it doesn't even have its own zipcode."

Bertrand Dionne retired from Northrop Corp. in September, 1986 after ten years of service and is currently employed by McDonnell-Douglas in Long Beach. . . . A news clipping notes that **Ernest Henrichon** has become vice president of product development at Scientific Systems, Inc., in Cambridge. He had previously been a vice president at Hendrix Technologies, Inc.

Louise and I have been busy with a vacation trip to England and her tenth reunion at the Harvard Business School. The mid-day cravings for a

pint of bitter have pretty well subsided; the rest of England was wonderful, too. Regarding the reunion, I sent along a few suggestions to **Bill O'Halloran**, our 25th reunion chairman. Bill can use your ideas and help; give him a call at (617) 942-1203 (office).

After all of the above, the cupboard is bare. Please send some news, recollections, opinions, whatever.—**Joe Kasper**, Secretary, 3502 Idaho Ave., N.W., Washington, D.C. 20016

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The usual dearth of news was broken up by a couple of real honest-to-goodness letters from classmates this month. **Henry Lichstein** writes that he is back again working for the chairman of Citicorp, John Reed, '62, as an "assistant to" and "chief of staff." Henry also says that he's enjoying life with wife Janine and their sons, ages 13 and 16. Henry still travels extensively, but the family also has a small house on the east end of Long Island for quiet weekends.

Wayne Wilner writes that Bell Labs has sent him on an extended field assignment to MCC in Austin, Tex. He is supervising a group of researchers who create advanced computer languages and novel architectures in support of the artificial intelligence, human interface, and database programs. Wayne and family are in their tenth house and report that moving still has surprises. After five years in a house that had a basement and an attic, they had to dispose of a ton of belongings in order to fit into one moving van, while after the previous 11 years in California (without attics or basements) they had accumulated only a fraction of a van. From this, Wayne speculates that matter is created spontaneously in attics and basements. (Could Wayne be en route to being the class of 1965's first Nobel laureate in physics?) Wayne also risks rekindling a war between the states by claiming that the subculture native to Austin is superior to that of New England, the Atlantic states, the Great Lakes, northern California, and southern California. He says he met more neighbors during the first week in Austin than he ever knew in any other state, that salespeople are friendly and helpful, and drivers are polite. The price, says Wayne, is that newcomers have to learn how to party.

Another Austin resident, **Jim Sprinkle,** was appointed last September to the first Charles E. Yager Professorship in the Department of Geological Sciences at the University of Texas. He is still studying extinct fossil echinoderms but has been struggling to finish an old project started while an undergraduate at M.I.T. Wife G.K. and children David, 13, and Xochi, 10, are doing well, and G.K. has become a successful public-interest lobbyist in Austin. . . . **Charles Seniawski** was promoted to colonel in the air force in August of 1986 and is now assistant deputy commander for maintenance of the 90th Strategic Missile Wing at Francis E. Warren A.F.B., Wyoming.

J.D. Roach has joined Manville Corp. as chief financial officer and senior vice-president. J.D. had been a partner of Braxton Associates in Houston. J.D. will direct Manville's corporate planning and development activities at its headquarters in Denver. . . . **Mike Keehner** has been named a member of the management committee of Kidder Peabody. Mike continues to head Kidder Peabody's oil and gas division and energy-financing and direct investment units. . . . **Richard Ayers,** president and chief operating officer of the Stanley Works, was one of 64 recipients of M.I.T.'s 1987 Corporate Leadership Awards.—**Steve Lipner,** Secretary, 6 Midland Rd., Wellesley,MA 02181

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Another two books by **Tom McDonough** have been published: *Space: The Next 25 Years* and his first novel, *The Architects of Hyperspace.* Tom teaches at Caltech and coordinates the search for extraterrestrial intelligence at the Planetary Society. . . . **Stuart Shapiro** is editor of *The Encyclopedia of Artificial Intelligence*, recently published by Wiley. He is full professor and chairman of the department of computer science at SUNY Buffalo, where he has been since 1978. . . . Our class castle owner, **Stewart Madnick,** reports that his son Howard is graduating from M.I.T. with a BS from the Sloan School, with a concentration in organizational behavior.

Joe Shaffery joined Arrow Electronics as treasurer in March. Theresa teaches in Huntington, N.Y. . . . **Norm Rubin** is director of nuclear research at Energy Probe and is a director of Science for Peace. . . . **Harry Moser** is president of Charmilles Technologies, the North American subsidiary of a Swiss company. He has been to Europe five times in the past six months, twice with Mary Jo. He is relearning French and German and having a great time. He lives in Lincolnshire, Ill. . . . **Joseph Bravman** is president of Fairchild Communications and Electronics Co. He and his wife, Ellen, live in Potomac with their two boys, Danny (4) and Kenny (2).—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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Our well organized 20th reunion was a huge success. Our thanks go to the many individuals who contributed to its success, and in particular to **John Rudy** and **Bob Ferrara**, who spent more hours on planning and implementation than can be counted. About 100 classmates attended the reunion—a spectacular turnout, and 160 people attended the Friday dinner at the Fogg Museum. Among our distinguished guests was Howard Johnson, president of M.I.T. from 1967 to 1973 and chairman of the M.I.T. Corporation from 1973 to 1983. The perfect weather of Saturday afternoon found 190 classmates, friends, and family members enjoying clams, mussels, chicken, and lobsters on Thompson's Island in Boston Harbor. More fun followed Saturday night at the M.I.T. boathouse, and on Sunday the Red Sox scored eight runs at Fenway Park but still lost by ten (which, according to **John Rudy**, is only 35 cents a run, a real bargain). During festivities on Thompson's Island, the following class officers were elected: **Jeff Wiesen**, president; **Bob Ferrara**, vice-president; **Jim Swanson**, secretary; **John Ross**, treasurer; and **John Rudy**, class agent and reunion chairman. More information on attending classmates will follow in the next few issues.

Don Mattes has left Silicon Valley for the East Coast and now lives in Huntington, Long Island. In June of 1986, he became president of Savant Instruments, a manufacturer of equipment for biotechnology research labs. . . . **Richard Cunningham** writes that his tenth child was born November 10, 1986, and that he has had to temporarily discontinue public service due to the cost of raising a family. . . . **Sara Law Schlenker** became an associate of the Casualty Actuarial Society last May and has been with Allstate Insurance for seven years.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

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Having lived in Washing over 15 years now, we thought we were veterans. We'd seen it all—drenching humidity, violent thunderstorms, roads sheathed in ice, paralyzing snowfalls, terminal gridlock, interminable cocktail parties, political elections. . . . Little did we know, Washington had one more test up its sleeve. As if summers here are not bad enough, once every 17 years brings a plague of large, noisy cicadas ("17-year locusts"). For a few weeks this summer, Washington, together with a good part of the southeast, turned into the set of a bad Alfred Hitchcock movie. Malevolent insects dive-bombed us whenever we ventured outside and crunched beneath our feet where we walked, and all around us, the incessant, grating—maddening—buzzing. However, as I write this, I can happily report that the worst is over and we seem to have survived. Now we must really be veterans.

The first order of business this month is to congratulate now fewer than four members of our class who have been elected to the grade of Fellow of the American Physical Society. They are: **Gary Bjorklund**, of IBM's research laboratory in San Jose, "for pioneering work in nonlinear optics and . . . laser spectroscopy"; **Gail Gulledge Hanson**, of the Stanford Linear Accelerator Center, "for contributions to the discovery and study of new particles. . . ."; **Shirley Jackson**, of AT&T Bell Laboratories, "for contributions to the theory of charge density wave instabilities, the channeling of heavy ions in solids, and the behavior of 2-D electronics on helium films"; and **Paul Langacker**, associate professor of physics at the University of Pennsylvania, "for contributions to understanding modern elementary particle theory."

Ron Merrill is presently director of research at Balenco Enterprises, a pharmaceutical manufacturer. He is also the founder of a high technology venture, and has counseled numerous small ventures as part of the M.I.T. Enterprise Forum in Cambridge, New York, and Los Angeles. He and co-author Harry Sedgwick recently published a book, *The New Venture Handbook*, to help guide emerging growth companies through the startup process.

Joseph Langsam has recently been named a vice president by Morgan Stanley, the New York based international investment banking firm. He joined Morgan Stanley in 1985 as a senior research analyst in the Taxable Fixed Income division. Formerly, he was an assistant professor of mathematics at Case Western Reserve University. He now resides in Millburn, N.J.

Claude Gerstle writes that "I just celebrated the first anniversary of my ophthalmology practice, having gone through a very painful and very, very expensive corporate 'divorce' from my former partners—where I was for ten years. I also just celebrated my son Ari's Bar Mitzvah, where we got together with **Steve Finn**, **Rich Ehrenkrantz**, and **Len Mausner**."

Paul Forbes is now living in Augusta, Ga., "appropriately named 'The Garden City', and site of the Master's Golf Tournament." As a result, he has resumed playing golf after a 25-year lapse. He is still working for Bechtel and building nuclear power stations.

Scott Marks reports that the Marks family is happily settled in Chicago, where Scott is General Manager of the Bankcard (VISA/MC) business for First Chicago and Pam is a homemaker, very busy with three small children—Steven (6), Peter (4), and Cayce (1 1/2). He is living downtown in an 1870's townhouse they renovated in 1984.

Michael Krashinsky writes that he has completed another sabbatical and has returned to teaching after three years as associate dean at the University of Toronto. He notes that, "My family grows older—my three children are now 12, 10, and 5—all closer in years to being undergrads than I am!"

Steve Ostrach has remained close to M.I.T. He reports that he left the Attorney General's Department in Massachusetts early in 1987 to begin work as a corporate and securities lawyer for The New England, a group of financial services companies headquartered in Boston. Linda is getting her doctorate in education from Harvard this year and their boys are 5 and 2.

From much farther afield we hear from **Shan Cretin**, who writes, "Our family is living in Chengdu, Sichuan at West China University of Medical Sciences for six months while my husband Emmett Keeler and I are studying the question of how to provide health insurance to peasants. Our daughters Lauren and Alexis (9 and 8 respectively) are enrolled in the local Chinese elementary school. My daughter Mikala

Woodward (17) is studying Chinese in a college level program in Beijing and will attend Swarthmore College in September.

Charlotte Babicki, who is still living in Yellowknife, Northwest Territories writes, "I don't have any exciting news, but I do have —stashed away in my old Coop crate—the sheet that led the old tuition protest: '$1900 Too Damn Much!' It used to hang in the 3rd floor lounge and I brought it away with me when we graduated." We will pass on to the M.I.T. Museum their offer to donate this historic document to the Institute, but I hope we can first take her up on her offer to let us use it for our reunion festivities next year."

And finally, some brief notes from several classmates: In April, **Richard Scott** joined the publications department at Stratus Computer, Inc., and is thus far enjoying his move to "the real world." **Ken Marko** reports "three kids and holding." He is still at Ford, "doing more applied work than physics these days." And last but not least, a very succinct note from **Steve Gamer**: "I am involved in consulting."

At our own end, Mike has recently gone into the "enforcement" business, working for the Field Office Bureau of the Federal Communications Commission, where he uses high tech to identify and catch those who misuse the airwaves. As a result of a massive reorganization, I am now heading a regulatory development group at the Nuclear Regulatory Commission.—**Gail** and **Mike Marcus**, Secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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The 4th of July is upon me and it's time to do the October notes. **Edward M. Waibel**, now vice president for strategic planning at General Business Services in Germantown, Md., writes: "In addition to my involvement with strategic issues and product development, I have responsibility for all corporate MIS (including VAX minis, DOS micros, networks, and related office "high tech") . . . **Robert Randall** adds in a note that he is "enjoying retirement or as Bob MacDonald ('68) puts it, self-unemployment." I like it! . . . **Samuel Leader** writes from Sebastopol, Calif., "I have started my own systems consulting company in the last 18 months. My son, Samuel III (6) has completed his second science fair project. My daughter, Genevieve (4) will enter kindergarten in the fall." . . . A brief note from **William Bengen**: "Am leaving soft drink business in New York and moving to San Diego." . . . **Jeffrey Lepes** makes this cryptic announcement: "I would like to publicly thank the former Director of Admissions, Pete Richardson, for giving my wife, Layne, the confidence to ski Upper Walking Boss (an expert slope at Loon Mountain in N.H.). Thanks to his timely intervention and guidance, I am still happily married with two children." **Steven J. Pecsenye** writes from Toledo, Ohio that he is president of a start-up software house called Woodley Rollins Associates that specializes in business software for the Hewlett-Packard 3000. The IEEE *Reflector* reports that **Dan E. Dudgeon** is one of a number of "Fellow Award Recipients" for contributions to multi-dimensional digital signal processing. He is currently an Assistant Group Leader at M.I.T. Lincoln Laboratory in the Machine Intelligence Technology Group. . . . Dr. **Mark L. Braunstein**, who has been with National Data Corp. in Atlanta, Ga. since 1978, was recently promoted to executive vice president, health care. A note from the company says that it is the largest independent provider of transaction processing services to the health care, financial, and retail sectors.

John R. Smith writes with gusto: "1986 has been an exciting year for us. Vivien was awarded a Ph.D. from UCSF in July, and we celebrated by touring Europe in October. Highlights of the trip included Oktoberfest in Munich and motoring at a steady 235 kph on the autobahn! With the interior decorating of our home in Palos Verdes Estates complete, we are now involved in planning the exterior amenities, which will include a pool, spa, and N/S championship tennis court. In addition to our present careers, we are also launching real estate and consulting ventures. Maturity brings wisdom, and the realization that time is the only limiting factor that one must really ultimately contend with and overcome." Really. . . . **Robert D. Bressler** is now at 3M Corp. involved with local area networks and working with alumni including **Larry Birenbaum**, **Howard Charney**, and **Pitts Jarvis**. . . . **Robert M. Metcalfe**, Silicon Valley entrepreneur (Chairman of the Board of 3Com in Santa Clara) and inventor, has made a $1.6 million gift to establish a new professorship linking engineering and the liberal arts at M.I.T. The goals of the fund are to foster programs and collegial relationships that interweave the humanities, the arts and the social sciences with engineering, according to the gift agreement.

Now I'll toot my own horn. I've just finished proofing the galleys for my science/philosophy book, *The Quickening Universe: Cosmic Evolution and Human Destiny*, which will appear in your favorite bookstore shortly after you read this, about mid-November. It's had good reviews by several notables and I suspect that many of you would be enlightened or inspired by it too—Hint, hint.

Well folks, that's all of success and inspiration I can offer this time around. Till we meet again in B. Dalton or elsewhere, I remain your trusty chronicler.—**Eugene Mallove**, 183 Woodhill-Hooksett Rd., Bow, NH 03301

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Donald Anderson received tenure at Woods Hole Oceanographic Institute at Woods Hole. He is living with his wife and two sons in Marion, Mass. . . . **Wesley Moore** is doing advanced tactical fighter analysis for Boeing and is a part of a team with Lockheed and General Dynamics. He also spends some time listening to the Cream and the Doors. . . . **Alejandro Chu** is taking the 12-week program for management development at Harvard Business School. . . . **Robert Moore** is setting up and is the first director of SRI International's Cambridge Computer Sciences Research Center in Cambridge, England. He is specializing in artificial intelligence and the related areas of computer science.

Eric Clemons is married and lives in Bryn Mawr. He is a tenured associate professor of decision sciences at the Wharton School of the University of Pennsylvania. This year he is initiating and directing a research project in information systems, telecommunications, and business strategy, a cooperative effort with a dozen industrial sponsors run through Wharton's Jones Center of Management Policy and Strategy.—**Robert Vegeler**, Secretary, Beers, Mallers, Backs, Salin and Larmore, 2200 Ft. Wayne Bnk. Bldg., Ft. Wayne, IN 46802

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The reunion was terrific! **Bonnie Kellermann** and her committee organized a diverse and fun-filled weekend. We started with Friday night rollerskating and chili party run by **Dick Fletcher**. Saturday **Bonnie Miller** took charge of the whale watch, and she provided us with wonderful weather and a mother and her baby whale. **Marina "Nina" Bartley** took time off from lawyering out of her home for the Saturday night dinner dance at Endicott House. Sunday the class brunch and meeting was held at Faneuil Hall. **Linda Mayeda** who has been doing a great job as class agent gave a report on the status of our funding of the class of 1972 UROP Endowment.

Steve Warner writes that he is currently working in Atlanta. Kimberly-Clark transferred him, after he had joined the company so he could live in rural Wisconsin. He is a materials scientist who is also an adjunct professor at Georgia Tech. In December 1985 Steve married Ruth Witmer. They are now living in Acworth, Ga., raising chickens, sheep, and old vehicles (57 Healey, '54 Studebaker, and Saab). Steve works out, competes in triathlons, last year winning the AAU triathlon sprint championships for 30-40-year old men. . . . **Edward Rich** is still in Midland, Mich. . . . **Deborah Bovarnick Mastin** and her husband, James, had their second son, Jonathan Solo Mastin, on April 30, 1987.

Joel Weisberg has been promoted to associate professor in physics and astronomy at Carleton College. . . . **Doug Mahone** is now a senior associate at Charles Eley Associates in San Francisco, architectural energy consultants and technical writers. Doug, Lisa Heschong (M.Arch. '78) and their two kids live in Albany, Calif. Lisa's doing well, designing houses out of the dining room. . . . **Stephen Glazier** is a securities and corporate lawyer in New York. He is doing venture capital deals, stock issues and mergers and acquisitions for new technology companies. He has filed for three patents on his own ideas. . . . **David Cutright** is with Technical Data International in Boston.

Rowland Williams is manager of quality assurance and regulatory affairs for Thermedics Inc., in Winchester, Mass. He also manages catheter development, but bicycling (sub-set mountain bikes) and his 3-year-old Sarah really push his hot button. Good luck to wife Stephanie on a safe delivery of the second, which was due approximately July 4th! . . . **Bradley Billetdeaux** is leading a management sciences function at Exxon in Houston. Many projects use operations research and artificial intelligence disciplines. He is getting his hands dirty working on details as well as coordinating. Brad's proud of M.I.T.'s work in each area.

Anson Whealler was the arrangements chairman for the Instrumentation and Measurement Society IMTC/87 Conference. He is with Teradyne. . . . **Paul Levy** is trying for the job of executive director of the Water Resources Authority. . . . **Joe Edwards** has moved up to Maine to be in charge of the state insurance commission. . . . **Rodney T. Regier** is building harpsicords and fortepianos in Freeport. His wife Shirley Mathews uses them in her performances, when she is not teaching at the Peabody Conservatory in Baltimore.

Rafael L. Bras, professor of civil engineering, has been appointed director of MITES at the 'Tute. He also heads the department's Water Resources and Environmental Engineering Division. . . . I am sad to have to announce that **Philip J. Scanlon, Jr.**, died in October 1984. We just became aware of it as part of the reunion mailing.

Back to more reunion notes. **Jerry Horton** hands down out-skated the rest of the class on Friday night. Jo-Anne and **Duncan Allen** joined us Friday and brought their children to the whale watch on Saturday. Duncan has been active with the M.I.T. club of Washington, D.C., where he was a past president. . . . **Gail Thurmond,** her husband Dick Gordon, and their oldest Robbie came up from Memphis. Gail is busy with her practice and in her spare(?) time has decided to open a shop with little boutiques in it. A lot of classmates made the trip from California, including **Stephen Chessin** (at IBM); Lynn and **Seth Cohen** (who actually are about to move there with a venture capital company); **Paul Hirsohn** (living in Berkeley working for a technical company and taking lots of photographs at the reunion); **Cherie Kushner** and Robert Fleming, '71 (living in Marin County, inventing and developing software, with a collection of over 10,000 books, more than half of which are science fiction titles); and **Sandy Wiener** (still at Stanford, of course . . . who would leave there?).

Speaking of collections, **Bob Ebert** made the reunion but did not bring his classical records, which line three quarters of his dining room. He is enjoying teaching at Boston University. Other Boston area alumni made the reunion including,

Kathy Kram, her husband Peter Yeager, and their tiny baby Jason; **Roger Putnam** who has finally stopped being a student after collecting a string of degrees in course VI; **Hikaru P. Shimura,** who came back from a business trip to Tokyo for the reunion and then flew back again; and **Steve Henry,** who continues to manage the class purse strings as well as his law practice.

John Fenner came down from Maine, where he owns and runs Snow Hill Garage. . . . **John Sullivan** took time off from his law practice in Chicago to come out with his wife Beth. . . . **Eduardo Pires-Ferreira** combined business and pleasure and came up from Brazil. . . . Terry and **Cynthia Tobias** came out from Pennsylvania where she continues to be active with the Opera Co. of Delaware. . . . **Larry Fisher** took time off from medicine in Flint, Mich., to bring his family out East.

The New York area was also represented by **John Gunther,** who is busy with his computer consulting business in Rosendale, N.Y. Also Jenny and **Li Conan** and Ellen and **Bernard Gitler**. Melissa and **Michael Rowny** came up from Washington, D.C. Michael has been busy with the companies he has been buying. Our reunion had a huge turn-out for a 15th reunion. A great time was had by all thanks to the work of the reunion committee.

Next month Dick can finish the reunion news with the various award winners. Obviously the reunion started the summer great. I just had to cancel my summer ender of backpacking in the Brooks Range in Alaska, so, hopefully, as you are reading this in October, I will be in the Grand Canyon with some other friends. Keep your news and notes coming.–**Wendy Elaine Erb,** Co-secretary, 531 Main St., Apt. 714, New York, NY 10044

Wendy Erb, '72 class secretary, and John Fenner, '72, enjoy some 70s rock music at an Endicott House dinner dance, part of their 15th reunion. Class of 1972 made the first 15th-reunion gift ever, in the amount of $96,895.

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A few notes this month. **Steven Waller** is still a physician with the Air Force, heading out to the Philippines this summer. He expects to be a flight surgeon with an F-16 squadron there. His wife Jane will be the Air Force's only ophthalmologist between California and Germany. . . . **Sylvia Weatherford** is presently serving as the president of the National Council of Black Engineers and Scientists, and is preparing for their fall conference. . . . **Bill Malik** is an advisory programmer in business plans for I.B.M. in Poughkeepsie, N.Y.—". . . like 6.251 forever!" . . . **Willy Shih** and Richard Pini ('72) just joined Bill in the same division.

Glenn Sharfin is currently living near Ft. Lauderdale, Fla., practicing orthopedic surgery and enjoying the sun with his wife Phyllis and kiddies Andrea (1), Jackie (3) and Dan (5). **William Short** shared the 1987 Inventor of the Year award from the Intellectual Property Owners, Inc. The award, shared with his colleague Amar Bose, was for their work on the Bose acoustic wave music system.

Regular readers will be thrilled to hear that the wife and kids are doing well, or at least better than their breadwinner's sinuses are. Eric ('96) is about to enter the eighth grad, Jr. ('03) the first. In the S.P.E.B.S.Q.S.A. world, Daddy's quartet, the Portsiders, placed third in a field of 22 this May to earn entry into the barbershop society's Mid-Atlantic District contest in October. This unexpectedly lofty spot caught a lot of the attendees by surprise, particularly the four of us, and my wife and kids ("Daddy's group?")—**Robert M.O. Sutton, Sr.**Secretary, "Chapel Hill", 1302 Churchill Ct., Marshall, VA 22115

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Let's start out with apologies to **Johan Kristofer Norvick** for short-changing him academic titlewise. A few months ago I referred to him leaving his "assistant" professorship at the Instituto Centroamericano de Administracion de Empresas. In reality, Johan was an adjunct professor and director of the Information Systems Program at that Costa Rican graduate business school. I had no idea of the importance of title but will mind myself in the future. . . . One man with a lot of irons in the fire is **George Harper,** who writes that he was ordained as a minister in the Presbyterian Church in April 1986. He's working on a Ph.D. in church history at Boston University, he was a National Graduate Fellow there this year, he's been published in academic journals several times recently, and he and his wife Anne were expecting their second child in May.

Steven Projan is "alive and well and doing molecular biology at the Public Health Research Institute." . . . Marty and **Tessa Gorenstein Lebinger** are living in New Rochelle, N.Y., with their two daughters Tzepporah (7) and Batya (3). Tessa has a private practice in Pediatric Endocrinology and Diabetes, in White Plains. . . . In nearby Westchester, **Martin Cohen** is a senior research chemist at American Cyanamid. He and his wife Marie also have two daughters, Jessica (4) and Rebecca (2).

Jack Wolfe has been named to the Bryant College board of trustees, to serve for a two-year term. Jack is president and chief executive officer of Tytronics, Inc., of Watertown, Mass. Tytronics makes an automatic titrator, as one might suspect from the name, and Jack has been chief executive officer since the summer of 1986.

How about you? Whatcha up to? Please note my new address, and write.–**Lionel Goulet,** Secretary, 115 Albemarie Rd., Waltham, MA 02154-8133

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Allen C. Hart is a senior systems architect with Grumman Data Systems Division. He was recently given a two-year assignment by Grumman at the Software Productivity Consortium in Reston, Va. . . . **Jon Sass** is a planner in the Holyoke Public Schools, leading the drop-out prevention effort by working with junior-high students no one else wants. Says Jon, "It's very rewarding." He and wife Christine have a baby, Molly (1) who "is a delight." . . . **Sherwood C. Pidcock** is a microcomputer analyst for the Boston Public Schools. . . . **Jeffrey S. Schaffer** is a manager of office automation, designing office data systems, office networks, pocket switching networks, corporate PC policies, and information centers. He's located in Mountain View, Calif., but he forgot to tell me for what company he does all these things.

John M. Hoffman completed a sports medicine fellowship in Toronto and now practices orthopedic surgery in Davenport, Iowa. He puts in long hours but thoroughly enjoys himself. . . . **Leonard Jay Weiss** has a private medical practice in Birmingham, Mich. He is board-certified in internal medicine and nutrition. . . . Congratulations to **Storm Kauffman**, who earned his Tae-Kwon-Do black belt in January.—**Jennifer Gordon**, Secretary, c/o Pennie and Edmonds, 1155 Ave. of the Americas, New York, NY 10036 or 18 Montgomery Pl., Brooklyn, NY 11215

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The mail has brought us some news. **Carl Shapiro** has been promoted to an associate professor at Princeton, where he has been teaching since 1981, with the exception of the 1982/83 academic year, when he taught as a visiting professor at Stanford's Business School. Carl holds an Alfred P. Sloan research fellowship, awarded in 1985. He is co-editor of *The Journal of Economic Perspectives* and associate editor of the *Quarterly Journal of Economics*. He has also authored and co-authored ar-

PHOTO: DAVID GRAHAM, '87

May the Best Price Win

John Hanzel, '76, Finds Homes for Antiques

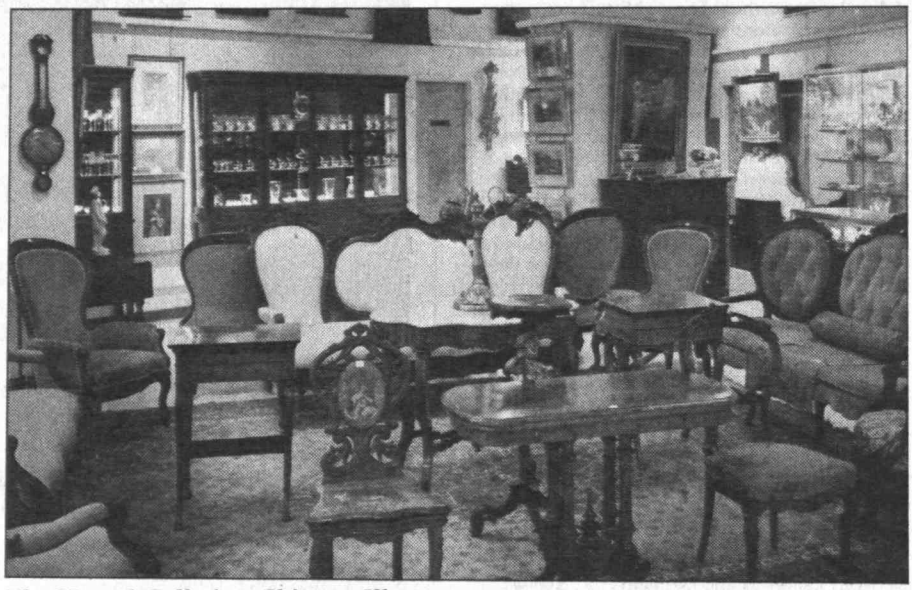
BY DEBRA CASH

Auction fever does exist," says John Hanzel, '76, and he should know. The 33-year-old scion of a Chicago auction house family has watched the once-staid art market heat up. From his vantage point, it seems that everyone who has a little money to invest wants to own an original art work or a piece of fine furniture. "The lure is the thrill of the chase," he explains. "People come in looking for one perfect piece, and once they start bidding, they don't want to let go. It's common to overhear someone say, 'I saw a painting by that artist 20 years ago, but I couldn't afford it then.' They've been longing for it all these years and when they come to auction, they want to be able to finally take it home."

John Hanzel graduated from M.I.T. with a bachelor's degree in management with an emphasis on computer science. At M.I.T. he worked for *The Tech* and after graduation spent a year working for the Harris Corp. training people on electronic newspaper editing systems. When he finally joined the firm his father founded during the 1940s, Hanzel could be his own boss instead of working for a large corporation. He hasn't looked back.

The Hanzel Galleries holds 8 to 10 major sales a year, grossing $3.5 million annually. Hanzel says that he researches and sells about 15,000 art works a year in all media, from paintings to decorative objects to furniture.

His trade has changed with the times. "When my father started off in the 1940s, auctioneers sold the bulk of their offerings to professional dealers. It was a slow-paced, club sort of atmosphere," Hanzel says. "People knew each other well. These were the people who could be expected to pick up three complete dining room sets at a single sale. But in the late 1960s, we began to attract buyers who didn't necessarily rely on dealers and who wanted to invest against inflation."



The Hanzel Galleries, Chicago, Ill.

The Chicago art and antiques market is skewed towards 20th century objects—the Great Fire of 1871 destroyed the examples of older American and European pieces that can be found on the East Coast and in specialty houses.

"By the late '70s, people were touting art and antiques as an investment. Prices—especially at the big international auction houses like Sotheby's—were going through the roof. It's not unusual anymore to see a watercolor go for $165,000 or a single chair bring in $2,300. A hand-carved duck decoy recently went for $150,000—and there were two bidders!" Hanzel lets some amazement creep into his voice, but he is philosophical about what these mind-boggling prices mean. "Occasionally, you think people went crazy," he shrugs. "But in a sense, the prices are not inflated at all. If collectors recognize duck decoys as indigenous American art objects, their bids represent the law of supply and demand being acted out right before your eyes."

Would-be bidders, Hanzel warns, have to be willing to make mistakes. "Both dealers and auction houses give directions and try to help customers figure out how to make good decisions. In my case, I do the initial appraisals and try to steer people toward ways to increase their own expertise." And he's especially pleased when he can help other M.I.T. alumni—who come to his gallery or who meet him through the M.I.T. Club of Chicago—take the plunge.

What types of art and antiques does John Hanzel collect himself? Not many, he admits a little sheepishly. "I have a small condo and not much room," he says. "I don't need to collect things because my job allows me to have different antiques and art works around me for weeks or months at a time. My job," says John Hanzel, "is to find art works happy homes." □

ticles for the *American Economic Review* and *The Journal of Political Economy*.

From **Janice Bestul Ossman**: "My husband Bill Ossman ('79) and I are proud to announce the birth of our daughter Rachael Elizabeth on December 18, 1986 (Class of 2008?). She is a real pleasure. We are living in Amston, Conn., where we have been for 3 years. I am working for Stone and Webster in Waterford." **William Ezell**: "I now have a son, Scott, 2. I am working on a major contract with a Japanese company. Frustrating, but quite interesting. 14 hours on a plane each way, however, is no fun. Still with David Dick ('74) and Marta Greenberg ('75) at SII, the company Dave and I started 10 years ago! Hard to imagine where all the time has gone."

Tom Moran is "working at Stanford University Hospital. I manage and develop Stanford Hospital's Clinical Lab Information System, an on-line system which interfaces blood and fluid analysis equipment to a mini-computer and processes all related data. I recently started a company to market products and services related to medical information needs. I have a 4 year old daughter, Lisa."

And from **Wayne Hamburger**: "My computer services company, Affordable Technology Group, has doubled in size in the past year—up to 11 employees. We are moving into new offices with 50% more space in October. My wife, Roberta, is now with Template Graphics, after spending four years with ISSCO. Even our 3 year old son Kyle is into computers, playing with MacDraw on his home MacIntosh."

We have a note from **Dan Christman**: "It's hard to believe that I have stayed in one place so long. I have been with Rohm and Haas Company for nearly seven years, and all in the same department except for a four month assignment to a start-up at our Louisville, Ky. plant. My musical activity has diminished slightly from a few years ago, but still keeps me pretty busy. I am still playing regularly with three symphony orchestras, a concert band, and a fife corps, and for special programs at various churches. There seems to be plenty of demand for oboe and English horn. . . . I have been getting more involved in Christian singles groups. Last year, I was active with eight groups affiliated with six churches. With all these groups, there is never occasion to wonder how to spend a Saturday night. I admit my involvement in the above areas may be considered a bit excessive, but I could think of worse things in which to overindulge."

Jean Hunter and **Tom Hirasuna** "have just had a son. Jeffrey Toshiro Hunter Hirasuna, born May 12, 1986. We are still both at Cornell. Jean is an assistant professor in the Agricultural Engineering Department. I am a graduate student/research assistant in Food Science."

Ron Solomon writes, "After M.I.T. I spent 18 months doing Multiple Sclerosis research at Albert Einstein in the Bronx. I took off to Liege, Belgium, to study medicine. The seven year program was abridged to six - my four years at M.I.T. gave me one year equivalency. The first year, with a new language (High School French doesn't get you very far), new culture, and new school system (oral exams, weekly over 2 months of "finals week") was very tough and will give me recurrent nightmares long after I've gotten through my internship. After that, though, the next five years grew more and more enjoyable. The Belgians are warm, friendly people. I was sad to leave, despite the weather. I will be completing my psychiatric residence this June, and staying on staff here at the University of Connecticut. I'll be with outpatients at the VA and in a lab working on the relationship between mental illness and the GABA-A receptor. The more important topic of my life: I got married to Pamela Sue Lorch two years ago and we now have a ten month old daughter, Rebecca Elizabeth, who is our joy. She was born July 4, 1986. Pam works full time in a small law firm nearby. She took only one month off after the delivery—can't hold her down."

A brief note from **Diana Dickinson**: "My two kids are delightful if exhausting. I'm working free lance, and the Boston summer is wonderful this year." Your secretary had a brief phone conversation with **Chris Roberts**, who is doing well at Atlantic Aerospace, which he helped found. They continue to do consulting to the U.S. government. As for your secretary, life is very full, between futures brokerage, trading, and his family. I remain amazed at how fast the time elapses. Trading futures does not help make the world slow down, either. Instead, the introduction of new markets and expanded trading hours has only accelerated the passing of time. I suspect that this feeling is endemic in our class. Your comments would be greatly appreciated.—**Arthur J. Carp**, Stalco Futures, Inc., 225 West 34th St., S. 1705, New York, NY 10122, (212) 736-1960

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Robert Shin, who completed his Masters of Sciences and Ph.D. degrees in electrical engineering in 1980 and 1984 at M.I.T., is now on the research staff at Lincoln Laboratory, and will be giving a talk this fall for IEEE on microwave remote sensing of earth terrain surfaces. . . . **Cynthia Koelker** is currently living in Appalachia, fulfilling her NHSC obligation, doing family practice. Cynthia has two children: Celeste, 7, and Adam, 2. Cynthia still plays the piano, but remarks that her horn is gathering dust. Summer plans for this year include hosting a European exchange student. . . . **Jim Pollock** is working for Structural Measurement Systems in San Jose as a marketing manager. . . . **Ed Cluss** is working for Rolm Corp., and living in Los Gatos.

Charlie Shooshan provided me with some brief news of our 10th reunion. Over 100 people attended. The activities went well, and the weather cooperated. Informal activities inluding brightening the paint on the '77 Smoot on the Harvard Bridge. Our new class officers roster follows: **Charlie Shooshan** continues as class president. **Ira Goldstein** is now vice president. Our Execcom consists of: **Kevin Miller**, **Dave Dobos**, **Eric Black**, and **Walter Goodwin**. Last named, but perhaps most important to many classmates is our new secretary/treasurer, **Ninamarie Maragioglio**. Ninamarie has lots of notes from the reunion, and she'll be publishing them in her first column, the November/December issue.

Parting words? It's been fun, and somewhat hectic, doing this column for the last 6 years. I will always have a tremendous appreciation for all the secretaries who strive to meet the deadlines, I'll continue to look forward to reading about all my classmates here. That's all from me, **Barbara Crane**. Please note your new secretary's address.—**Ninamarie Maragioglio**, Secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153

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They say that you can always tell how long a class has been out by checking the content of its class notes. Well, ours is no exception; our topic of the month is (typically) babies! (Next month is real estate.) Let's start with Abigail Ann Fraeman, second daughter of Marty and **Kathy Hardis Fraeman**. Kathy, Marty, Abigail and older sister Dora live in Rockville, MD, near D.C. . . . **Jonathan Ivester** writes that he and his wife had a baby boy, Benjamin born in December, just as their daughter, Elizabeth, had turned age 2. Jon just got promoted to materials manager for a new division at Applied Materials. . . . **Jim** and **Diane Hutchinson** write that they "are busy rearing two active preschoolers, soon to be research pros. We have a four year old, James, and a two year old, both thoroughly enjoyable. Jim is busy at Acuson in ultrasound imaging plus MSEE studies."

I recently got a card from Jeremy Katz, son of Marion and **Howard Katz**. Jeremy writes: "Just letting you know that I was born on March 12, 1987. Daddy has been working at AT&T Bell Labs

New class secretary Ninamarie Maragioglio, '77, chats with Dave Dobos, '77, during their 10th reunion last June. The class gift set a new record of more than $55,000.

in Murray Hill, N.J. on molecular recognition and nonlinear optics, and will be lecturing on those topics at the National ACS Meetings. My older brother Joshua (Class of '06) says hi too."

By the time this is printed, **John Jaynes** and his wife should have had their second child. John writes that (s)he "looks to be a true Texan", whatever that means. John was recently promoted to senior analyst in marketing planning at American Airlines, and still "plays Navy" one weekend a month. . . . And, there is now another **Timothy J. Reckart** in the world; Timothy Jr. was born last December 29.

Yvonne Tsai had to work at it, but she found me a boring postcard from China (PRC), where she was touring with her husband Scott Kukshtel ('79), brothers ('81 and '83) and her mother (honorary '78). The postcard is a picture of the Main Hall of Imperial Vegetarian Dining Palace. She writes: "Touring all the sites from Ghiwn (sp) to Beijing and back via Hong Kong. Met long lost cousins (plus a few I could do without), climbed the Great Wall, rode in Russian made cars (no suspension, no pick-up) on Chinese highways (picture this: 77 Mass. Ave., rush hour, Friday, all the cabs in Boston, 2 dozen tracter lawnmowers towing bamboo rods 15 ft. long, 3 water buffalo, add 1 ton of pebbles and 2 boulders for good measure.)" Yvonne is now practicing ophthalmology in Derry, N.H. She adds: "Looking forward to our 10th reunion."

Speaking of our 10th reunion, the time has come to start planning your return to Cambridge. It only happens once every five years, and it's fun. I think it will be the weekend of June 10, so call a friend, get your plane reservations, find a living room to crash on (ours is available at low rates) and come play. And, of course, we are always looking for volunteers to plan or run events. Write to me at the address below.

Barry Linder's job always fascinates me—he is working as Staff Assistant on the NASA Advisory Council's Life Sciences Strategic Planning Study Committee, assigned to the Operational Medicine Study Group. At the same time, he is finishing up his residency in Ophthalmology. Of course, I wouldn't guess that **Tom Webster** has been bored either; he writes: "I have been a research adjunct at the City University of New York. My research concerns the chemistry, physics and biology of toxic air contaminants. I am particularly interested

PHOTO: DAVID GRAHAM, '87

in the environmental problems of solid waste and provide advice to many concerned citizens groups on the issue."

Short notes: **Alan Markham** writes from Palo Alto that he is having a grand time at Sun Microsystems, and sharing the fruits of his wife's vegetable garden. . . . **Paul Maki** is living in Acton, Mass. and is a staff member at M.I.T.'s Lincoln Labs. . . . Also in the Boston area is **Richard Brudnick**, just promoted to president and chief operating officer of James Brudnick Co. . . . As a commercial banking officer for First Bank Minneapolis, **Alice Campbell** works mostly with small start-up companies. "So, as a result, I'm now on the public speaking circuit with topics like 'Sources of Funds for Your New Business' and 'How to Ask for a Loan'."

Geoffrey Baskir, frequently mistaken for Stickles, is still at the Dallas Fort Worth Airport after six years as a planner. In his spare time he is involved with the M.I.T. Enterprise Forum of Dallas/Fort Worth, and "free radio" overseas in Britain under the auspices of the Four Freedoms Federation. . . . **Sheila Luster** and husband Kevin Wade ('79) are now in Goldsboro, N.C. Sheila left the Air Force and is with a civil engineering firm in downtown Goldsboro, while Kevin flies F-4's for the Air Force.

Finally, there's my wife. We survived two complete years of M.I.T. tuition as Yuko got her masters from the Sloan School; now I look forward to a period of positive net income. For me, I've just set a personal record of being on the same job for 20 consecutive months—going on 21! Will wonders never cease. Make me wonder; send news, gossip, confusing letters, and boring postcards to—**David S. Browne**, Secretary, 50 Follen St., #104, Cambridge, MA 02138

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Kenneth Murphy is in the U.S. Air Force and finishing his first year of residency in anesthesiology at Wilford Hall Medical Center in San Antonio, Texas. Kenneth reports the sad news that his wife Kristin passed away on February 22 after a car accident 10 days earlier. Our sincerest sympathies to Kenneth. . . . **Jan Hack Katz** got her Ph.D. from the Sloan School in 1984 and has recently joined the faculty of the Johnson Graduate School of Management at Cornell University. . . . **Lee Weinstein** is a medical staff fellow in endocrinology at the National Institutes of Health in Bethesda, where he also resides. . . . **N. Scott Kukshtel** is a microcomputer software engineer for Powerbase Systems, Inc., in New York City. His wife, Yvonne Tsai, '78, finished her fellowship in pediatric ophthalmology at Manhattan Eye and Ear Hospital, and they planned a July move to southern New Hampshire, where Yvonne is joining an ophthalmology practice and Scott "will be working somewhere along Route 128/495."

Thatcher Root was married in September of 1986 in Minneapolis to Jennifer Siegel. **Ed Tarney** was in attendance as best man; Ed lets Thatcher return the favor in October, at Ed's wedding to Carole Troisi in Lake George, N.Y. Thatcher and Jennifer have moved to Madison, Wisc., where he is starting as assistant professor in the chemical engineering department at the University of Wisconsin. . . . **Mark Finlay** is manager of software development for IVEX, Inc., in Atlanta, and has just presented a paper on fractal terrain synthesis at SPIE's Southeast Symposium on Optics in Orlando. Mark and Nikki's son celebrated his first birthday on May 5, and their second child was due in mid-August. . . . **Alan Schauer** has given up his status as perennial student and has accepted a professorship in microbiology at the University of Texas at Austin.

Jeremy Nathans recently won both the 1987 Passano Young Scientist Award and a National Academy of Sciences research award. Jeremy, who got his Ph.D. in biochemistry from Stanford in 1985 and his M.D. there this past June, will receive grants of $15,000 from each award. The Passano Foundation (established in 1943 to encourage medical research in the U.S.) recognized Jeremy for his isolation of the genes that specify the three color-sensitive pigments of the human eye. . . . **Mike Rapheal** and his wife Joanne (Wellesley '81) live in Woodside, Calif., where Mike is a freelance architect and Joanne graduated from Stanford Law School in May. Also scheduled to occur in May; delivery of their first child. . . . **Sajeev John** has been promoted from instructor to assistant professor of physics at Princeton. Sajeev got his Ph.D. from Harvard in 1984, and was at the University of Pennsylvania until September 1986 as a postdoctoral fellow of the National Sciences and Engineering Research Council of Canada. . . . **Norm Guivens** is out of the Navy after five years and is now an engineer at SPARTA, Inc., in the Boston area.

Robert and I were at M.I.T. recently for his 10th reunion. There weren't many people there that we knew, but we had the chance to make some new friends, as well as get together with some old ones: Lisa and Howie Boles, '77, and their daughter Bethany, Katie and Ken Turkewitz, '80, and their son Max, and Monty Solomon, '78. I didn't run into any '79ers, although **Mike Patrick** and **Jim Walker** were allegedly registered for some activities, and **Lilly Lee Lettvin** was listed as being on the Technology Day Committee. The highlight of the weekend was a ceremony on the Harvard Bridge honoring Oliver Reed Smoot, '62, who was there on the occasion of his 25th reunion. Mr. Smoot says that contrary to legend, he was not rolled across the bridge, but instead assumed a pushup position 365 times to that he could be accurately measured (and he also gave us a glimpse of the now-famous ear).—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

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Hello again! I hope that everyone had a great summer. I was happy to receive a number of letters and postcards this month. I hope that this will continue. I thank those of you who have written and encourage the remainder of the Class of 1981 to write and tell us all what you are up to!

Dick Gorman wrote to say that he and his wife Andrea had a baby boy, Richard John Jr. on December 31, 1986. Dick is a director at Ansa Software in Belmont, Calif. Congratulations! . . . Fellow DU member **Jim Williams** is a third year resident at Parkland Memorial Hospital in Dallas, Tex. Jim married Sandra S. Crockett of Philadelphia on February 21, 1987. Another of the DU contingent, **Colin Shepherd** reports that he and his wife Jacki have moved to Los Angeles this June and have purchased a home. Colin is moving with Gerald D. Hines Interests (real estate development and investment) to open a Southern California office for them and to build a 50-story office building in downtown L.A. Jacki hopes to transfer with her advertising firm Ogilvy and Mather.

I have received numerous announcements that **Lisa Parechanian Allen** has been named the national recipient of the Materials Research Award. Lisa received her Ph.D. in March from the University of California at Berkeley. Lisa is back living in Norton, Massachusetts. Congratulations are also in order for **Sandra Zack Litwin** and her husband Stuart on the birth of their second daughter, Tamara Rae. . . . **Jeff Watiker** is an attorney in Washington, D.C. with Gibson, Dunn and Crutcher. . . . **Mark Findeis** recently received his Ph.D. in chemistry at Harvard and is living in Manhattan where he is working on a postdoctoral fellowship at Rockefeller University. Mark reports that he has neither rowed or run since the 1985 Boston marathon. . . . **Claudia Busher** wrote to say that she is in her second year of a grad school at M.I.T. and that **John Keklak** is working at New England CNC, a startup formed by John and two others to write and sell software for CNC machines.

Bank of Boston sent a press release announcing that **Alfonso Canella** was appointed an investment officer at the bank. Anybody need a loan? Finally, on the international front, **Jon McCombie** is working for Cambridge-based BBN Communication in Stuttgart, West Germany as a manager of software support. Jon says he is having fun overseas but looks forward to his eventual return to Boston. Well, that's all I have for October. Please do your piece to increase the length of this column. Please write!—**Lynn Radlauer Lubell**, 216 Beacon Street, Boston, MA 02116

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Lynn Schnapp graduated from medical school and is now doing her residency at the hospital of the University of Pennsylvania. . . . **David Kushner** finished medical school at Case Western Reserve University, then did an internship in internal medicine at Mt. Sinai Medical Center, and now is in diagnostic radiology at the Medical College of Ohio in Toledo. . . . **Lori Alperin** works at Bell Labs in Murray Hill, N.J., in artificial intelligence. . . . **David S. Wilson** flies E-2 radar planes off aircraft carriers for the Navy. His homeport is N.A.S. Miramar, near San Diego. . . . **Brian Glass** is finishing his Ph.D. at Georgia Tech and moving to the San Francisco area. . . . **Chris Braun** finished his Ph.D. at the University of Southern California in plasma physics. He's army-bound to fulfill his R.O.T.C. commitments.

Matthew Prete lives on Beacon Hill and loves every minute of it. He manages software development at Datext, Inc. . . . **Michael Isnardi** graduated from M.I.T. with a Ph.D. in E.E. He toured the U.S. and Canada and then joined R.C.A. Labs, working on improved television systems. . . . **John Hainsworth** works for DEC in Shrewsbury, Mass. . . . **Alan Laves** got married in January, practices corporate law with a large firm, and enjoys both. . . . **Patrick Bigot** finally got out of the Navy and is now assistant director of the M.I.T. Practice School at Dow Chemical. . . . **Thai Duc Trinh** finished medical school at Johns Hopkins. He's an intern in pediatrics and will return to Johns Hopkins to complete a residency in diagnostic radiology. . . . **Gary Henderson** received a master's in M.E. from Stanford and works at Lockheed Missiles and Space Co. as a research engineer.

Postcards continue to come from **Eddie Torres** and **Mark Schmaier**. They set out on "a mission from God": to play the top 100 golf courses in the United States; but they are now taking a detour, hitting golden oldie golf courses anywhere. They stopped off at St. Andrews in Scotland, which is over 800 years old. . . . **Crystal Lynn Barker-Schaaf** has been keeping busy. She married **Rich Schaaf** and bought a house in Sudbury, Mass. They worked the wedding into their busy lives after Crystal's Alpine Meteorology Conference in Venice, Italy. Rich joined Crystal in Italy, Crystal presented her paper, and then they went off for some pre-wedding sight-seeing. Back to Boston just nine days before their wedding—which, Crystal points out, saves wear and tear on the bride since she was simply not available for harrassment before the wedding. They had the wedding at the M.I.T. Chapel. Bridesmaid **Joanne Bos** sang at the wedding, and ushers **Ed Kearns** and **Brian Michon** assisted best man **Ken Powell** in getting the groom through the wedding. Ed is working on his doctorate at Harvard, and Brian is being supported by Digital Equipment Corp. while he gets his master's at Stanford. Crystal is leaving the Air Force (but planning to stay in the reserves) and taking a civil service job at the Air Force Geophysics Lab at Hanscom Air Base, where she has been working for the last four years for the Air Force. Rich has been working at Bolt, Beranek and Newman on parallel processors.

George Thayer completed training for the A-4M Skyhawk. George is a first lieutenant in the Marines. . . . **Curtis Stern** is married to Marianne

Wiese. He finished his Ph.D. in mechanical engineering at Berkeley and now is assistant professor at Virginia Tech in Blacksburg, Va. . . . **Roslyn Romananshi** was married last year to **Gregory Wojcieszak**. Bridesmaids included **Erin Hester, Jennifer Knowlton**, and **Margaret Sano**. Attending the wedding were **Maureen Delaney, Laurel Carney, Dave Chin**, and **Carla Ponn Chin**. Rosalyn graduated from SUNY/Buffalo School of Medicine last year. She and Greg live in Providence, R.I., where Rosalyn has an internship in internal medicine at Rhode Island Hospital. . . . **Robert Chase** is working hard and trying to start a new wave rock band, but needs a good drummer. . . . **Thomas Wendel** has been married since 1981 and now has two children, Daniel and Anna. He works as a machine design engineer and lives in Nashua, N.H. . . . **Gary Kratkiewicz** had been working for Motorola in Florida but is now at Stanford working on an M.S. in manufacturing systems engineering. Kendra, '84, went with him. The note from Gary was brief, but I gather that Kendra is his wife.

M.K. Ravel sends news of one of the class's more unusual marriages—his own. M.K. took off to bum around Asia for five weeks. He spent his first week at Rishikesh, a small town in the foothills of the Himalayas. M.K.'s brother was getting married there, and M.K. was planning to use the wedding as an excuse to stop in Thailand and Malaysia for four weeks after the wedding. But no, said the Fates, those devilish three (to quote from M.K.'s letter). M.K. met Ms. Right at his brother's wedding. Her name is Nedam, she's studying for her Ph.D. in plant genetics, and she too loves the mountains, etc., etc., etc. M.K. proposed after three days, they were married after two weeks, and M.K. spent the rest of his trip traveling with his unexpected company and living happily ever after. M.K.'s moral of the story: Enjoy singlehood—it may end more quickly than you know.

Faithful readers will notice your secretary's new address. I am entering Berkeley graduate school to do what I always wanted to do but never had the talent for: thinking.—**Rhonda Peck**, Secretary, 556 N. Mentor Ave., Pasadena, CA 91106

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Just to show that you can meet anyone in a large city at any time, I ran into **Eric Martinot** walking down the streets of San Francisco. He is with P.G.and E. and is a member of the Green Party. . . . Two more people I saw on the street were **Paul Bradford** and **Eric Munroe**. We all had just finished the Bay Breakers race, along with over 70,000 other people in the area.

David Sarr is now in Haiti, serving as a Peace Corps volunteer. . . . **Marc Williams** is "still hacking computer orthodontia for the U.S. Air Force, until I can trick M.I.T. into letting me back in (and the Air Force into letting me out, of course)." . . . **Karen Welch** is back in Boston after two years in Warren, Ohio. She is starting her second year at Harvard Business School. She says, "I've run into a lot of classmates here—**Cheryl Washington, Bill Lapoint** and **Johan Magnusson**, to name a few. I saw **Vykki Rodak** just after Christmas and she is crazy as ever—last time we talked she was also thinking about going back to school." . . . **Nora Okusu** is studying mechanical engineering at U.C. Berkeley and hopes to finish her master's degree by the end of the year.

I must apologize to **Dave Alexander** for forgetting to mention him in a previous column. He has been in the mechanical engineering department at Stanford for a year now. After working at Silicon Graphics this summer, he is finishing his degree at Stanford. . . . I am still in sunny California, where I recently went to the Jose Cuervo Beach volleyball tournament in Santa Cruz. See what you could do if you lived here too?—**Mona Wan**, Secretary, 10480 Creston Dr., Los Altos, CA 94022

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Tom St. Louis works for Pfizer, Inc., in Groton, Conn., as a process engineer. After hours, he coaches and officiates for youth programs in soccer and baseball. A while back he had the pleasure of housing upteen Lambda Chis for the wedding of **Tim McKenney** and **Kathy O'Keefe**. . . . **Chris Zannetis** is engaged to Jennifer Hess (Wellesley '86). Chris graduated from Sloan and now works for Data General in Massachusetts. . . . **Karen Phelan** works in New Jersey as a consultant in management advisory services for Deloitte, Haskins, and Sells. . . . **Phillip Huggins** writes from Columbia, S.C., "I'm back in the sunny south with my own design/build firm specializing in custom wooden decks. Another lotech techie achieves a higher state of 'deckadence.' " . . . **Eric Liebeler** writes, "**Steve Creighton** is in Tokyo. I think he's at NEC, doing his best to further agitate trade friction. . . . Rumor has it **Roy Wetherbee** has a job, but we're all skeptical. . . . I just saw **Rich Higgens** this weekend—he's still chipping away at his Ph.D."

Samuel Lafontaine lives in Clevelend, Ohio, where he works for Allied-Signal Bendix Heavy Vehicle Systems. He is involved with advance braking systems which will be put to market in the mid-1990s. . . . **Patrick Peters** has graduated from officer training school at Lackland A.F.B., Texas, and was commissioned a second lieutenant in the Air Force. . . . **David Neman** is employed at Schlumberger Well Services in Houston, Texas. He loves the working world, especially the warm weather that goes along with it in Texas. He says, "M.I.T. was great, but I wouldn't want to live there." . . . Here in Schlumberger, San Jose, Calif., **Adrian Wang** told me about his great business trip to Schlumberger, China. He managed to squeeze in a week of vacation by missing his flight back.—**Stephanie Winner**, 1026 Live Oak Dr., Santa Clara, CA 95051 (408) 985-6827

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Dear fellow' Tutesters, I received a letter this month from an irate classmate demanding to know why I wasn't including the information he had sent me. Well, I did include his contributions, it just takes a while. As I explained in my first article, there is a four-month lag time between my deadline and the issue hitting the newsstand. So, please, be patient. Be assured, if I receive your information, it will get printed.

Okay, Kids, what's the deal? I only received three letters this month. The purpose of this column is to let everyone know what everyone else is up to. That can't happen if no one writes in. So, put away the bathroom cleaner, the lawn mower, put down whatever you're doing and drop me a line. It'll only take ya ten minutes.

Dennis Cuy wrote me from Utah. He's working for TRW. He says Utah isn't bad and the skiing was pretty awesome . . . **Steve Brandwein** and **Alan Hildebrand** came to visit earlier this year. Steve is studying at Northwestern, and Alan's at Yale. Dennis ran into a fellow engineer at work; Dave Maxwell, '66, who works for Rockwell. Dennis noticed Dave was carrying a binder with 16.01 on the spine. Boy, it seems like we're all over . . . **Sarah Danca** works for TRW in San Bernardino. She likes everything there but the earthquakes.

John Juliano sent me a very interesting note, only excerpts of which I can print. No, it wasn't that bad. Anyway, John is in Glen Burnie, MD. pitching short relief for the Baltimore Orioles under the assumed name of "Mark Williamson." I can only assume that John is less than thrilled with Glen Burnie as he writes that "this town should be blown up, immediately." Both he and John Rulnick have expressed concern over the frequent appearances of one of their fraternity mates in this article, so I'll try to curb my inclination to mention **Greg Harrison.** By the way, Greg is still enjoying himself in Los Angeles.

My last letter comes from **Vic Christensen.** He's living in San Pedro, CA and managed to get up to Edwards AFB to see the Voyager aircraft. While there, he tried to get in touch with Ken Katz, '84, but Ken was away on business. Vic was visited by Terry Hohol, '85. Terry will be getting married to Pat O'Donnell in mid-1988.

Well, so much for letters. **Doug Norton** and **Jerry Martin** called me while they were in the area. Doug is working for Hughes out here, but Jerry was visiting for a shooting match. Jerry is going back to M.I.T. to work on his Ph.D. in nuclear engineering/materials . . . **Rich Maurer** also called me. He is in Lubbock, Tex. learning to fly aircraft for the air force. Sounded like he was really enjoying himself. I ran into Keith Ashelin, '83, again at a party in mid-June. He, too, is in the air force here at Space Division . . . Lt. **Brett Pichon** graduated from the AF Aircraft Maintenance Course at Chanute AFB, Il. . . . Lt. **Edward Schmitt** graduated from the Army Engineer Officer Basic Course at Ft. Belvoir, Va. **Anna Lisa Fear** has announced her engagement to **Jeffrey Kenneth Goodwin.** They live in Oakland, Calif., and Anna Lisa works for Cetus in Emoryville . . . **Michael Bates** is back home in Tulsa working for Burtek, a company specializing in flight simulation. He's involved with a project that is rebuilding a C-141 simulator using Ada. John writes, "so far, to my disgust and amazement, the M.I.T. class which most contributed to my getting this job and doing well on it is 6.170, which I dropped midway through the semester." I met Diane Peterson, '84, at Bobby McGee's in Long Beach. She's still at TRW and, having made a job switch, is finding life much more enjoyable.

Hae Jin Baek and **Rajir Bahl** are employed by Goldman Sachs in New York City. . . **David Bailey** works for Booz Allen and Hamilton in Bethesda, Md. . . . **Karen Baker** is at the Brigham and Women's Hospital in Boston . . . **Derek Barkey** is with the McDonnell-Douglas Corp. in Long Beach . . . **Elisa Barzelay** works for 3M in Minneapolis . . . **Mary Bayalis, Mike Berger,** and **Gina Buccellato** are grad students at University of California, Berkeley . . . **Carolyn Beer** is at the University of Illinois, and **Lisa Bell** is at the University of Texas, Austin.

Daphne Benderly is with Case Western Reserve . . . **Scott Berkenbilt** is studying at the Harvard Medical School . . . **Adam Bernard** works for GM in Warren, Mich. . . . **Greg Berthiaume** is at Penn State, and **Toi Beveridge** is at Carnegie Mellon . . . **Lara Bespolka** works for First Boston in New York City, and **Gary Blackwood** and **Michael Blair** are studying at M.I.T. . . . **Wilbert Blake, John Briggs,** and **David Brent** are employed by Wang Labs in Lowell, and **Ron Bloom** is with Boeing in Seattle.

Alessandro Bocconcelli is a student at the Woods Hole Oceanographic Institute, and **Kent Boklon** is at the University of Michigan . . . **Hannah Bond** works for Corning Glass, and **Jim Boyles** works for Soundtrack in Boston . . . **Laura Bonney** is at the University of California, San Diego . . . **Roy Briere** is at the University of Chicago, and **Werner Brooks** is at Duke Medical School . . . **Alice Brown** is a student at University of Washington, and **Margaret Burke** is at Johns Hopkins University . . . **Ray Brunsberg** works for the Soltex Polymer Corp. in Texas, and **Tim Burke** is with Martin Marietta in Orlando.

Jim Butler is an ensign in San Diego, and **Susan Byrne** is with Keystone Provident in Boston . . . Finally, **Brian Byun** is employed by Hewlett-Packard in Cupertino, Calif. So much for the Bs. if I didn't include you and you are a "B" person, it means you probably never returned the locator card sent to you by the alumni office.

The Los Angeles regional party scheduled for June 27, 1987, was delayed, as a few of you know. By the time this is printed, we should have thrown it—let's hope we can keep the police from showing up like they did at my last party.—**Mary E. Cox,** Secretary, SD/CLTP, P.O. Box 92960, LA AFS, Los Angeles, CA 90009-2960

CARLOS PRIETO, '58

Performing at Kresge on October 24.

Mexico's Leading Cellist Returns to Alma Mater

BY DEBRA CASH

Fate conspired to make Carlos Prieto, '58, a cellist. He was in his cradle when his parents decided he should begin lessons as soon as he was big enough. Once he did, his parents reasoned, the family could play string quartets together, with mom and dad on dual violins and grandfather on viola. When he was four, the Prietos put a bow and a miniature instrument into the boy's hands.

"Coincidentally, I loved the cello and so I never had any regrets," Prieto says now. But this doesn't mean that he followed a prodigy's musical vector. On the contrary; he may be recognized as the foremost cellist in Mexico today, but he spent the first 20 years of his adult life as a steel company executive.

Contacted by phone while on a tour stop in Texas, Prieto recalled that at age 16, he was at a pivot point in his life: "I had completed studies at the conservatory, but I was also interested in math and physics." He worked hard to prepare for his SATs—taken in English, his second language. "If I had not been accepted to M.I.T., the choice would have been simple. I would have started a musical career." But M.I.T. offered him a place, and he could not decline.

In 1958, Prieto received a bachelor's degree in Course III, metallurigal engineering, and the following year his second bachelor's degree, in economics.

Life in Cambridge wasn't all problem sets for Prieto. Professor Laurens Troost, who then headed the Department of Naval Engineering, played violin, and his wife played piano. Mechanical Engineering Chair Jacob Den Hartog and his wife were also skilled amateur musicians. On weekends, Prieto shuttled from Troost's apartment near his own dorm room and the Den Hartogs' Concord house—playing chamber music with one couple on Saturday and the other on Sunday.

Prieto joined the M.I.T. orchestra in 1957, and was appointed first cello under the direction of conductors Claus Lipmann and John Corley. Somehow, he also spent "endless hours" listening to the "fantastic collection" of recordings in the M.I.T. music library.

After graduation he returned to Mexico to work at the offices of Fundidora Monterrey. One day in 1960, the steel plant had some visitors: a delegation from the Soviet Union, headed by then-Minister of Trade Anastas Ivanovitch Mikoyan. "I was always interested in languages and had studied Russian at M.I.T. with Professor Znamensky," Prieto remembers. "When Mikoyan's interpreter fell ill, reluctantly I took the job of translator." Somewhat capriciously, Mikoyan invited Prieto to study in the Soviet Union—and gave instructions to the Russian ambassador to arrange Prieto's acceptance to the University of Moscow. Prieto confesses that he had almost forgotten the incident until two years later when his permissions arrived in the mail.

During the six months Prieto lived in Moscow he worked on perfecting his Russian. But the trip also whetted his taste for a return to musical life. It was 1962, and composer Igor Stravinsky was about to visit his native land after half a century in the West. (As Prieto explains it, his family had made friends with the venerable composer when he came to conduct his work in Mexico. Stravinsky would often stop by for lunch or dinner.) Prieto contacted the controversial musical modernist, and ended up accompanying him during the three weeks of his stay in the Soviet Union.

"I could never keep music from my mind," Prieto remembers, but when he returned to Mexico he went back to his more traditional career. After all, he was married and had three children to support. In 1972, he became president of his company, and served as chairman of a number of professional associations, including the Mexican-Japan Business Committee and the Iron and Steel Industry Association.

He was 39 when he decided it was his "last chance" to attempt to have a musical career. He consulted cellist Pierre Fournier: "I asked him if I was absolutely insane." By then, Prieto admits, no one could have talked him out of his decision. Fournier was guardedly encouraging, but counseled hard work.

"I had to recover for lost time," Prieto explains. For several summers, he went to New York to study with Leonard Rose, "an exceptional human being and a wonderful teacher." By 1981 Prieto was named "Outstanding Soloist of the Year" by the Mexican Association of Music Critics. Three years later, he made his American debut, garnering a sheaf of reviews from hard-to-impress *New York Times* critics and others who praised his "impeccable" musical instincts and technical command.

On October 24, Carlos Prieto will return to M.I.T. to perform with the M.I.T. Symphony, this time playing the Dvorak cello concerto. "I'm especially thrilled to be coming," he says. "The last time I performed in Kresge auditorium was 30 years ago."

And if you're considering a drastic career change, Carlos Prieto has some rueful advice. "Most people enter musical careers from childhood and work without interruptions. The way I chose was the hardest possible way to do things. My advice is that if you have always wanted to do something different, make the change as soon as possible. Don't wait." □

PHOTO: MARTIN REICHENTHAL

COURSE NEWS

I CIVIL ENGINEERING

Hunter Rouse, S.M.'32, was director of the Institute of Hydraulic Research at the University of Iowa from 1942 to 1966, and he's now emeritus professor of engineering at UI. Now **John F. Kennedy,** a member of the faculty in M.I.T.'s Parsons Laboratory from 1961 to 1966 who is now director of the UI Institute of Hydraulic Research, has just been honored as the first Hunter Rouse Professor of Hydraulics at UI. Kennedy describes his predecessor as "one of the true giants in hydraulic research"; James O. Freedman, UI president, says Rouse's work has "left an important mark on the development of the discipline and brought great distinction to the University of Iowa"; and Rouse says of Kennedy that "a better choice of the first incumbent could not have been made. . . . The appointment actually honors me quite as much as it does him."

Russel C. Jones, who taught civil engineering at M.I.T. from 1963 to 1971, is now president of the University of Delaware, effective last July 1. . . . **Frannie Humplick,** S.M.'86, who is now a Ph.D. candidate at M.I.T., is winner of the $1,000 Bertram Berger Award of the Boston Society of Civil Engineers. Berger was a well-known Boston-area transportation engineer, and the prize that bears his name is for a young engineer demonstrating outstanding accomplishments in that field. Humplick's doctoral thesis will be in the area of transportation infrastructure analysis.

Richard J. Dauksys, S.M.'70, has changed jobs: from vice-president of marketing and sales at Pacer Technology and Resources, Campbell, Calif., to vice-president of marketing at Fothergill Composites, Inc., Bennington, Vt. . . . **Miguel Stanichevsky,** S.M.'82, reports from Paraguay that he is currently working for N. Sryvalin and Associates as project manager involved mainly in geotechnical and structural projects for building facilities. Since 1984 Stanichevsky has been teaching a two-semester course in geotechnical engineering in the School of Technology at the University of Our Lady of Asuncion.

Thomas A. Holden, S.M.'84, a major in the United States Army and assistant professor in the Department of Mechanics at West Point, N.Y., has been decorated with West Point's the Meritorious Service Medal for "outstanding noncombat achievement." . . . **Pierre Haren,** Ph.D.'80, now heads ILOG S.A., a private company specializing in artificial intelligence software located in Paris.

Richard M. Dillon, S.M.'50, writes from Toronto, "After 12 years of consulting engineering, 11 as dean of engineering at the University of Western Ontario, and 12 as executive director and deputy minister with the government of Ontario, I have happily semi-retired as a principal of Alafin Consultants Ltd., Toronto, public policy advisers to business and government." . . . **Ross T. McGillivray,** S.M.'68, has joined the Tampa, Fla., office of Dames & Moore as a senior engineer and project manager. He formerly served as vice-president and general manager of a geotechnical and geohydrological consulting firm.

Two alumni have been presented awards by the American Society of Civil Engineers:

□ **Fujio Matsuda,** Sc.D.'52, executive director of the Research Corporation of the University of Hawaii, Honolulu, the 1986 John I. Parcel-Leif J. Sverdrup Civil Engineering Management Award for "his service as a registered professional engineer, educator, and university president, and his leadership in planning design and construction of an internationally recognized, integrated transportation system."

□ **Robert V. Whitman,** Sc.D.'51, professor in the department at M.I.T., the Karl Terzahi Award, for "outstanding contributions to knowledge in the fields of social mechanics and subsurface and earthwork engineering and construction."

Two deaths have been reported to the Alumni Association with no further details available: Professor **G. Ross Lord,** of Toronto, Canada, on January 16, 1986; and **John B.K. Sur,** S.M.'59, of Honolulu, Hawaii, in 1986.

II MECHANICAL ENGINEERING

Ioannis V. Yannas, S.M.'59, professor of polymer science and engineering at M.I.T., was honored last spring by election to the Institute of Medicine.

Professor **Joseph L. Smith, Jr.,** Sc.D.'59, in the department at M.I.T. was honored last spring with the Edward Longstreth Medal of the Franklin Institute of Philadelphia. He was cited for his work "applying cryogenic techniques to mechanical processes."

Avraham Swartzon, S.M.'75, was promoted last June 1 to director of manpower planning and administration for maintenance and engineering at Eastern Airlines, Miami, Fla. . . . **Richard D. Webb, Jr.,** Sc.D.'87, has been promoted from a process engineer to principal development engineer at The Timken Co.'s Technology Center, Canton, Ohio. . . . **Dennis N. Assanis,** S.M.'83, assistant professor of mechanical engineering at the University of Illinois, Urbana-Champaign, is one of 32 engineering educators in the nation to receive the 1987 Ralph R. Teetor Educational Award. This award, presented by the Society of Automotive Engineers, is made to recognize educators for "their ability to successfully prepare individuals to meet the challenges that face society today."

Nicholas R. Tomassetti, S.M.'58, has been promoted from vice-president—marketing to president and chief executive officer at International Aero Engines AG, East Hartford, Conn. . . . **Richard P. Lindsay,** S.M.'66, research associate at the Norton Co., Worcester, Mass., received the Albert M. Sargent Progress Award of the Society of Manufacturing Engineers last May 4.

III MATERIALS SCIENCE AND ENGINEERING

Praveen Chaudhari, Sc.D.'66, is IBM's vice-president for science and director of the Physical Sciences Department at the Thomas J. Watson Research Center, Yorktown Heights, N.Y.; he's been at IBM since completing his M.I.T. doctorate. Chaudhari was a member of the National Academy of Sciences panel that last summer assured the National Science Foundation that its science and engineering centers were a good idea; they could make "significant contributions to science and to the nation's economic competitiveness," said the panel report.

Two major prizes to Professor **Thomas W. Eagar,** '72, of M.I.T. during the spring: the Champion H. Mathewson Gold Medal of the Metallurgical Society of AIME for "important contributions to the science and practice of welding"; and the Henry Krumb Lectureship of the Society of Mining Engineers of AIME. The latter involves a series of lectures on two subjects—technology transfer and the future of materials engineering, and cooperative research in Japan.

Institute Professor Emeritus **Morris Cohen,** Sc.D.'36, in the department at M.I.T. has received the prestigious Kyoto Prize in advanced technology for 1987. Cohen is noted for inspiring two generations of students and colleagues in materials science and engineering; and he has "not only laid the scientific groundwork for all the ultra-high strength steels in use today but also is responsible for such advanced materials sciences as shapememory phenomena and transformation platicity in metallic, ceramic, and biological systems," said the announcement. . . . **Thomas Vasilos,** Sc.D.'54, has been appointed professor of chemical engineering at the University of Lowell, Mass., effective this fall. Previously (since 1957), Vasilos has worked for Avco Systems Division, most recently as principal scientist and group leader.

Francois R. Mollard, Sc.D.'67, writes, "I have just rejoined Battelle Memorial Institute (I worked in their Geneva, Switzerland, operations during 1971-77), at their Columbus, Ohio, headquarters. I am manager, engineered materials development. Areas of activities include powder metallurgy, ceramics, glass, and composites. Previously I was technology manager for Cabot Corp., Reading, Penn."

Joseph R. Lane, Sc.D.'50, reports, "I am still, after 32 years, with the National Academy of Sciences, Washington, D.C., now on a part-time basis. Like others in our profession, I have been forced to become a 'general specialist' in the materials area, not just a metallurgist. I just returned from an interesting trip, spending two weeks in Hungary. I was with a small chamber music group (playing violin) which joined local amateurs in sight-reading sessions. A highlight was playing in the Esterhazy Palace while tour groups went through."

Praveen Chaudhari, Sc.D.'66, of the IBM Thomas J. Watson Research Center received the 1987 George E. Pake Prize of the American Physical Society, cited "for his outstanding management in enhancing the role of basic research in the electronics industry . . . and his scientific insight and creativity in understanding the structure and properties of amorphous thin films and fine lines."

In celebration of their 65th wedding anniversary, Edward Bowles, S.M.'22, and his wife Lois, pose for **The Wellesley *(Mass.)* Townsman.**

Bernhardt J. Wuensch, (Ph.D.'63, Course XII), TDK Professor in the department at M.I.T., has received the 1987 Outstanding Educator in Ceramic Engineering Award sponsored by the Ceramic Educational Council of the American Ceramic Society. . . . **William H. Rhodes,** Sc.D.'65, senior staff scientist at GTE Labs, Inc., Waltham, Mass., is president-elect of the American Ceramic Society. Rhodes is a past chair of both the Basic Science Division and the New England Section. He also served as vice-president (1985-86) of the Society.

John R. Anderson, S.M.'46, of Arcadia, Calif., passed away on January 22, 1987; no further details are available.

IV ARCHITECTURE

The name of **Lawrence B. Anderson,** M.Arch.'30, professor emeritus of architecture at M.I.T. who was head of the department and dean of the School of Architecture and Planning, is being given by the School of Architecture and Planning a new $10,000 biannual award. Open to professional architects who have been associated with M.I.T. as students, the award will be in the form of a stipend to complete documentation of an element of the built environment, the resulting documents to become part of the Rotch Library.

Professor **Chester L. Sprague,** M.Arch.'58, who became assistant professor of architecture at M.I.T. in 1966, retired to be associate professor emeritus last July 1. During his service on the Institute faculty, Sprague was outspoken in his support of the rights of native Americans, and he made several important studies of housing needs of Indians in the western states and Alaska. As a practicing architect, Sprague consulted with a number of Indian and advocacy groups, and he included minority housing issues in his studio and classroom teaching. Sprague's undergraduate architecture degree was from the University of Minnesota, and after receiving his Master's degree he taught at Arizona State University and the Rhode Island School of Design before returning to M.I.T.

Jay R. Carow, M.Arch.'62, has assumed ownership of a 12-person firm that is now named Carow Architects Planners, Chicago. The firm, formerly named Rockwell Carow Architects, specializes in design of public, commercial and office facilities and in historic building renovation. . . . **Takashi Arioka,** S.M.'86, writes from Kanagawa, Japan, "I have returned to my former position at Kume Architects Engineers in Tokyo. Now I am 'architect' in charge of two development projects in urban contexts of downtown Tokyo and Kanagawa. I will be a registered architect soon."

V CHEMISTRY

Professor **Christopher T. Walsh,** who has been head of the department at M.I.T. and Karl Taylor Compton Professor, has joined Harvard Medical School. Effective this fall, he heads a newly combined Department of Biological Chemistry and Molecular Pharmacology, and he is Harvard's David Wesley Gaiser Professor. . . . **John M. Deutch,** '61, provost, now holds the Compton Professorship.

To Professor **Stephen J. Lippard,** Ph.D.'65, of M.I.T., the 1987 Remsen Award of the Maryland Section of the American Chemical Society for "outstanding contributions to inorganic chemistry related to the preparation and function of bioinorganic substances, and to the synthesis, structure, and reactivity of organo-metallic complexes."

Nathan S. Lewis, Ph.D.'81, associate professor of chemistry at Stanford, recently reported in *Nature* a new crystal-liquid interface that makes possible a freer flow of electrons between a semiconductor and the liquid in which it is immersed. Applied to a solar cell, the new interface increased by 1 percent the efficiency of energy conversion. The work is important, says Lewis for a Stanford press release, because it contributes new understanding of "the behavior of electrical charges at (semiconductor) surfaces."

To **James Kinsey,** professor of chemistry at M.I.T., a $10,000 1987 Ernest O. Lawrence Memorial Award of the U.S. Department of Energy. He is cited as "one of the most creative and successful pioneers of modern chemical kinetics." Kinsey will become dean of natural sciences at Rice University, Houston, in January 1988. . . . To **Gerald D. Laubach,** Ph.D.'50, president of Pfizer, Inc., membership in the Institute of Medicine. . . . To **Walter H. Stockmayer,** Ph.D.'40, professor emeritus of chemistry at Dartmouth College, the National Medal of Science "for fundamental contributions to the physical chemistry of high polymers."

John C. Stowell, Ph.D.'64, professor of chemistry at the University of New Orleans (UNO), received a 1987 UNO Alumni Association Excellence in Teaching Award during commencement exercises last May. . . . **Melvyn M. Kassenoff,** S.M.'66, was promoted (last January 1) from senior patent attorney to associate director, patent and trademark affairs at the Sandoz Corp., the U.S. subsidiary of Sandoz AG. of Basle, Switzerland. Kassenoff resides in West Orange, N.J.

Glenn Doyle Daves, Jr., Ph.D.'64, chairman of the Chemistry Department at Lehigh University, Bethlehem, Penn., received an honorary doctor of pharmacy degree from the University of Uppsala, Sweden, last June. Daves was cited for his work including the isolation, structure, determination, and synthesis of biologically active compounds—with members of the faculty in the School of Pharmacy (at Uppsala) over the past 20 years. . . . **James J. Bishop,** Ph.D.'69, has been named to the newly created position of special assistant to the provost for minority affairs at Ohio State University, Columbus. Bishop formerly served as vice-president for university life at the University of Pennsylvania.

Howard E. Simmons, Ph.D.'54, vice-president of Du Pont Co.'s Central Research and Development Department, Wilmington, Del., received an honorary doctor of science degree from Rensselaer Polytechnic Institute last May 15. Simmons was cited for his "key leadership in developing major new programs in molecular modeling and biotechnology." . . . **William Larry Respess,** Ph.D.'66, has joined Gen-Probe, Inc., San Diego, Calif., as vice-president and general counsel. Respess formerly served in the same capacity at Hybritech, Inc., San Diego. . . . **Roger M. Freidinger,** Ph.D.'75, reports that on February 6, 1986, he received a Vincent du Vigneaud Award for Young Investigators in Peptide Research at a Gordon Research Conference in Santa Barbara, Calif. Freidinger was recently promoted to assistant director of the Department of Medicinal Chemistry at Merck Sharp & Dohme Research Laboratories, West Point, Penn. . . . **Raymond N. Domineg,** Ph.D.'82, writes that in August 1986 he accepted a tenure track position of assistant professor of chemistry at the University of Richmond, Va. . . . **Eugene O. Degenkolb,** S.M.'70, is currently a plasma etch engineer at the Digital Equipment Corp., Hudson, Mass. . . . **Clark W. Perry,** Ph.D.'63, is a senior principal scientist, Radiosynthesis Laboratory, Department of Biochemistry, at Boehringer Ingelheim Pharmaceuticals, Inc., Ridgefield, Conn.

John T. Blake, Ph.D.'24, a retired executive of the Simplex Wire and Cable Co., passed away in Hyannis, Mass., on June 26, 1987. Blake's career at Simplex began in 1924 as a research chemist, and he retired in 1966 as a senior vice-president, secretary, treasurer, director and member of the Executive Committee. Blake held several patents in rubber chemistry and in 1956 received an honorary doctor of science degree from Tufts University, later serving on several of Tufts governing committees. He was also elected (1981) honorary chairman of Cablewave Systems, Inc. . . . **Carlos L. Vila,** '78, of Coatesville, Penn., passed away on May 16, 1986. He was a member of the faculty at West Chester University, West Chester, Penn.; but no further details are available.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

To **William R. Hewlett,** '36, vice-chairman of the board of Hewlett-Packard Co., the Stanford University Associates' "Degree of Uncommon Man." Stanford, like M.I.T., gives no honorary degrees,

PHOTO: PETER DUNN

and the "uncommon man" designation has gone to only 11 people since its first presentation in 1953. Hewlett and David Packard, his partner whom he met as an undergraduate at Stanford, were jointly honored for "their unparalleled generosity to the university."

Electronic Flash, Stroke by Institute Professor Emeritus **Harold E. Edgerton,** '27, is now in its Third Edition (M.I.T. Press, 1987). New material has been added, and Edgerton has made "a few corrections" in material retained from the Second Edition.

Professors **Jack B. Dennis,** '54, and **Francis F. Lee,** '50, of M.I.T. retired on July 1 to become professors emeriti. Dennis has spent his entire teaching career at the Institute, joining the faculty in 1938 upon receiving his Sc.D. in the field of computer science. Dennis' teaching and research were in computer theory and systems; he is a specialist in computer structures and parallel processing, recipient of the 1984 IEEE Eckert-Mauchly Award for technical contributions to computer and digital systems architecture. Lee has been a member of the faculty since 1966, when he received his doctorate from the Institute, teaching in the fields of computer architecture and digital technology; and he has consulted widely on industrial applications of digital technology.

Robert N. Noyce, Ph.D.'53, founder and vice-chairman of Intel Corp., was chosen by the American Association of Engineering Societies to receive its $5,000 National Engineering Award for 1987. Noyce was cited for his co-invention of the integrated circuit and for his subsequent successful efforts to make large integrated circuits (LSI) a practical reality. AAES stipulates that the honorarium be used in furthering engineering education, and Noyce designated his prize to support the work of M.I.T. Professor **Seymour Papert** in the use of computers for primary education (*see "Computers in the Classroom," April, pages 52-64*).

Robert R. Martin, S.M.'76, of Medfield, Mass., is currently director of marketing for Ontologic, Inc., a development-stage company building an object-oriented database. . . . **Jon K. Clemes,** Ph.D.'63, is currently president and chief operating officer of the Chronar Corp., Princeton, N.J. Celmens was formerly staff vice-president for consumer electronics research, at RCA Laboratories, Princeton, N.J. . . . **Edward Bowles,** S.M.'22, and his wife Lois celebrated their 65th wedding anniversary on June 17, 1987. The secret to their matrimonial harmony, according to an interview in the *Wellesley Townsman*: "mutual respect and senses of adventure and humor have kept their marriage together." . . . **Henry N. Bowes,** S.M.'47, Houston program manager of the Lockheed Engineering and Management Services Co., has been promoted to vice-president. He continues to be responsible for the company's engineering and scientific support at the Johnson Space Center.

VI-A Internship Program

This issue reports on graduation and Technology Day activities—always a great time to renew acquaintances with the many VI-A alums returning to the campus. This year was no exception.

Graduation came first on Monday, and we saw **Philip H. Peters,** '37, heading up the 50-year class as its president. Phil is retired executive vice-president and director of the John Hancock Mutual Life Insurance Co. and a member of the same church in Wellesley Hills as your correspondent.

Attending graduation was VI-A'r **Thomas H. Crystal,** '60, and family to see son **Michael R. Crystal** receive his S.B. and S.M. degrees as a VI-A graduate. Also attending was **Holton E. Harris,** '47, whose son, **Walter D. Harris**, received his S.M. degree. Also graduating was **Stephen M. Day,** '87, son of **Chester M. Day, Jr.,** S.M.'58, and grandson of **Chester M. Day,** '28, both of the latter being VI-A grads. **Gregory D. Troxel,** '87, a VI-A'r receiving his S.B., is the son of **Donald E. Troxel,** Ph.D.'62, of our EECS faculty.

Technology Day on Friday began with the traditional Memorial Service in the M.I.T. Chapel to remember our alumni who departed during the previous year. Among them was **Eugene W. Boehne, Sr.,** '28, who headed up VI-A from 1947-1960, and **Karl L. Wildes,** '22, who assisted William Timbie in the VI-A Office for many years. Both were good friends and mentors to your correspondent over the years and now are sadly missed.

VI-A can be justly proud of its alumnus **Raymond S. Stata,** '57, who has been elected president of the M.I.T. Alumni/Alumnae Association. Ray is the founder of Analog Devices, Inc., and was instrumental in the establishment of the Massachusetts High Technology Council for which he served as president a while ago.

At the Technology Day Luncheon the gift from the 50-year class, the largest gift ever ($4.8 million), was presented to President **Paul Gray,** '54, by **Joseph F. Keithley,** '37, founder and board chairman of Keithley Instruments, Inc.

Elected an Honorary Alumna of M.I.T. by the Alumni Association and presented her certificate at the luncheon was Dorothy G. Adler, wife of EECS Associate Department Head **Richard B. Adler,** '43. Ms. Adler is coordinator of alumni recognition and selection.

VI-A Office visitor attending his class's 25th reunion was **Robert G. Kurkjian,** '62, on his way back from a European business trip. Bob is manager, Autotest Systems Laboratory, Hughes Aircraft Co., El Segundo, Calif. He mentioned several other VI-A friends with whom he has contact: **Robert E. Anderson,** '62, vice-president—corporate marketing, GenRad, Inc., Phoenix, Ariz., and **Robert G. Fulks,** 'S.M.59, with Telesis Systems Corp., Chelmsford, Mass.

Other VI-A's seen at Technology Day included: **William E. Northfield,** S.M.'57, now living in Osterville, Mass.; **Michael W. Patrick,** S.M.'80; **Daniel L. Smythe, Jr.,** Ph.D.'67, working at Lincoln Laboratory; and **Ronald R. Troutman,** '62, with IBM, Burlington, Vt.

Listed as preregistered were **John R. English,** S.M.'84; **Michael A. Isnardi,** Ph.D. '86, with SRI's David Sarnoff Laboratory; **Donald S. Levinstone,** Ph.D.'81; and **Michael Moncavage,** '82. Isnardi wrote later that his reunion was special: he became engaged over the weekend.

An important announcement is the change in management of the VI-A Internship Program. Effective July 1, 1987, Kevin J. O'Toole, N.E.'57, became its director. Your correspondent has moved to a position entitled special assistant to the EE&CS department heads, for VI-A—a position in which he will be advisory to VI-A and will have a broader base of responsibilities with the department commensurate with his past experience as departmental administrative officer and executive officer for student affairs. I hope alumni visiting the VI-A Office will stop in and make it a point to become acquainted with Mr. O'Toole, who began his service at M.I.T. in 1973 with Course XIII.

The ninth annual picnic for West Coast VI-A students and alumni was held a month earlier than usual this year to allow earlier acquaintanship of students in the area. Date and place were July 12 at Mitchell Park in Palo Alto. Total attendance was 63—approximately one-third students. For the third consecutive year the oldest attending alumnus was **Richard T. Perry,** S.M.'26, from Burlingame, Calif. Next was **David F. Tuttle, Jr.,** Sc.D.'48, and wife, Becky. Professor Tuttle is retired from Stanford University and was a good friend of the late Professor (Emeritus) Karl L. Wildes, '22. Arriving on their bicycle-built-for-two were invited guests James M. Early and wife, Mary. Jim has just retired as director of research and development from Fairchild Palo Alto Research where he co-ordinated the VI-A Program. Jim's daughter, **Kathleen Early,** S.M.'87, is currently a doctoral student in EECS at M.I.T.

This year's picnic went like clockwork—at least partly because the planning committee had several alumni carry-overs from last year. The successful idea of holding a dinner meeting of the

High School Astronomy: A Magnet for Science?

Young people have an innate interest in the sun, planets, and stars, says Professor Kenneth Brecher, Ph.D.'69, of Boston University, but only about 9 percent of American high school students today are taught any astronomy.

It's not only a loss for astronomy and for the students, but it's also a loss for science, says Brecher, because astronomy could ultimately lead many young people into science careers.

Now a group of astronomers is trying to change that. They've organized what they call Project STAR—Science Teaching Through its Astronomical Roots. They want to use astronomy as the "bait" to introduce students to a variety of important scientific and mathematical concepts. "They'll learn about dynamics, about light, about space and time, about matter." Brecher finds that students are intimidated by topics labeled mathematics or physics. "But if you say it's astronomy, it's something they're interested in anyway," he explained to David L. Chandler of the *Boston Globe* Sci-Tech Section last summer.

The project is based at the Harvard-Smithsonian Center for Astrophysics in Cambridge, but it involves many M.I.T.-related people. It was the brainchild of former M.I.T. professor Irwin Shapiro, now director of the center, and the STAR project director is Philip Sadler, '73. STAR has been developed with National Science Foundation funding.

STAR plans first to develop material that can be added to existing high school science courses and eventually to provide a semester-long (or perhaps a year-long) astronomy curriculum for high schools to teach.

A survey of 6,000 high school teachers shows a "strong desire" for such material, says Brecher. □

planning committee on the Friday evening prior to the Sunday picnic was repeated. This year's Picnic Planning Committee consisted of: **Jerrold L. Boxerman,** '88, **Yonald Chery,** '88, **John D. Chisholm,** S.M.'76, **Michael A. Fetterman,** '88, **John W. Jarve,** S.M.'79, John A. Tucker, and **Kenneth A. Van Bree,** E.E.'71. Thanks to all for an excellently executed function.

As best I can construct from memory and the sign-up list, the following alumni attended the picnic: **Allen J. Baum,** S.M.'74; **Elwyn R. Berlekamp,** Ph.D.'64, president of Cyclotomics, Inc., Berkeley, Calif.; **Richard A. Blanchard,** S.M.'70, with Siliconix; **Paul E. Braisted,** S.M.'80, with Trimble Navigation; **Michael Chessman,** S.M.'64, with Varian Associates, Palo Alto; **Robert M. Colopy,** S.M.'74; **John F. Cooper,** S.M.'76, with Personics, Inc., Menlo Park; **J. Payne Freret,** '68; **Mark T. Fuccio,** '80, with Daisy Systems, Inc.; **Daniel R. Helman,** Ph.D,'86, on the faculty at the University of California, Santa Cruz; **Alexander Holland,** S.M.'84, with Schulmberger Palo Alto Research; **Harrison S. Horn,** '49, with Intech, Santa Clara; **Thomas R. Kennedy III,** S.M.'87,; **Steven T. Kirsch,** S.M.'80, with Frame Technology; **Carl W. Linde,** '85, with Ungermann-Bass, Inc., Santa Clara; **Richard T. Perry,** S.M.'26, (retired) of Burlingame, Calif.; **Lynn M. Roylance,** '72, with Hewlett-Packard Laboratories; **Eric A. Slutz,** S.M.'75, with Hewlett-Packard Laboratories; **Jeffrey B. Winner,** S.M.'86, with Schulmberger, and his wife, Stephanie (Scheidler), S.M.'86; and **Craig L. Zarmer,** S.M.'84, with Hewlett-Packard Laboratories.

A call from **Andrew Chiang,** S.M.'81, told us he is now associated with a start-up company called Intellimed in Fort Lee, N.J. He also told us that **Kelly Pan,** S.M.'79, is now with Merrill Lynch in New York City. He and some other Chinese students have formed a Chinese Alumni Club as an affiliate of the New York Alumni Center. It has about 90 members so far, and plans are under way for a similar undertaking in the San Francisco Bay area.

In late May I had a call from **David W. Duehren,** S.M.'81, co-founder and vice-president, research and development for Brooktrout Technology, Inc., Wellesley Hills, Mass., who was interested in having a student to work for the summer.

We had a pleasant office visit from **Thomas Durgavich,** S.M.'76, and family. Tom is now president of Duralogic, San Jose, Calif.

We note with interest the promotion of **Allan C. Schell,** Sc.D.'61, to the position of chief scientist, Air Force Systems Command, Washington, D.C.

Also visiting the VI-A Office were: **Eric D. Black,** S.M.'81, from LaHonda, Calif.; **Juan C. Mercier,** S.M.'84, who tells us he's now studying for an M.B.A. at Stanford while working part-time for Hewlett-Packard, Cupertino, Calif.; **Scott C. Munroe,** S.M.'77, with M.I.T. Lincoln Laboratory; and Commander **John B. Patterson,** S.M.'68, who lives in California, Md., and is assigned to the Naval Air Systems Command, Washington.—John A. Tucker, Special Assistant to the EE&CS Department Heads, for VI-A, Room 38-473, M.I.T., Cambridge, MA 02139

VII BIOLOGY

To **Har Gobind Khorana,** Alfred P. Sloan Professor of Biology and Chemistry at M.I.T., the 1987 National Medal of Science "for his contributions to our understanding of gene structure, membrane function, and vision."

George M. Weinstock, Ph.D.'77, graduate school of biomedical sciences associate professor in the Department of Biochemistry and Molecular Biology at the University of Texas Health Science Center, Houston, was selected one of eight faculty members by the student body as an outstanding teacher for 1987. . . . **Emanuel Goldman,** Ph.D.'72, of Jersey City, N.J., received the Research Career Development Award from the National Institutes of Health (1983-88). . . . Professor **Robert A. Weinberg,** Ph.D.'69, a member of the Department at M.I.T. and of the Whitehead Institute for Biomedical Research, has received a $100,000 1987 General Motors Cancer Research Foundation prize. Weinberg, a pioneer in demonstrating the existence of oncogenes in cancers, was cited for "his contributions to the fundamental understanding of cancer." . . . **Cecily C. Selby,** Ph.D.'50, writes that she is newly appointed as professor of science education at New York University. "It's the only title I have not yet had in my long and varied career," says Selby. "Happily have chosen research and teaching, on which I started at M.I.T., as my final career."

VIII PHYSICS

Daniel Kleppner, Lester Wolfe Professor of Physics at M.I.T., completed work last summer on a National Academy panel commissioned by the National Science Foundation to study President Ronald Reagan's proposal for science and technology centers. The panel's conclusion: the centers could make "significant contributions to science and to the nation's economic competitiveness."

To **Philip Morrison,** Institute Professor emeritus at M.I.T., an honorary doctor of science degree from Carleton College, Northfield, Minn.

David Moncton, Ph.D.'75, has been honored by the U.S. Department of Energy with a $10,000 1987 Ernest O. Lawrence Award. Moncton is serving this year as interim associate director of Argonne National Laboratory responsible for the proposed advanced photon source; he was at Bell Laboratories from 1975 to 1982 and then at Brookhaven until the beginning of this year when he became senior research associate at Exxon Corp. Moncton was honored for "fundamental contributions" to understanding materials with neutron and x-ray scattering techniques.

Two distinguished members of the department at M.I.T.—Professors **Martin Deutsch,** '37, and **Herman Feshbach,** Ph.D,'42, retired to the rank of professors emeriti last July 1. A distinguished experimental high-energy physicist, Deutsch was director of the Laboratory for Nuclear Science for a number of years starting in 1973. Professor Deutsch came to the U.S. in 1935 from Vienna and remained at the Institute for his entire professional career except for a wartime leave of absence to work on the Manhattan Project at Los Alamos, N.M. Like Deutsch, Feshbach has been a longtime teacher at M.I.T.; he was instructor in physics when he received his doctorate, joined the faculty in 1945, and reached the rank of professor in 1955. Feshbach was director of the Center for Theoretical Physics from 1967 to 1973, when he became for more than 10 years head of the department; he was made Cecil and Ida Green Professor in 1976.

Professor **Robert J. Birgeneau** of M.I.T. was honored last spring with the American Physical Society's Oliver E. Buckley Condensed Matter Physics Prize. Birgeneau was cited "for his use of neutron and x-ray scattering experiments to determine the phases and phase transitions of low dimensional systems."

Professor **Henry W. Kendall,** Ph.D.'55, of M.I.T. is among the authors of *Crisis Stability and Nuclear War,* a report published early this year under the auspices of the American Academy of Arts and Sciences and the Cornell University Peace Studies Program. It's a summary of the several authors' collaborative study of paths that might lead the superpowers from a crisis to a nuclear war; Professor Kendall was a member of the study's steering committee.

PHOTO: BOSTON UNIVERSITY PHOTO SERVICE

Ralph Leroy McNutt, Jr., Ph.D.'80, associate professor in the department at M.I.T., has been nominated as a 1987-88 national finalist for a White House Fellowship. . . . **Mitchell Jay Feigenbaum,** Ph.D.'70, one of the founders of the field of chaotic dynamics and a newly appointed faculty member of The Rockefeller University, has been named the University's first Toyota Professor. Feigenbaum has received several prestigious awards, including the 1986 Wolf Foundation Prize in Physics, a 1984 MacArthur Foundation Award, and the 1982 Ernest O. Lawrence Award of the U.S. Department of Energy.

Stephen J. Lukasik, Ph.D.'56, vice-president for technology at Northrop Corp., was awarded an honorary doctor of engineering degree from Stevens Institute of Technology, Hoboken, N.J., last June. He was cited for "strong personal commitment to the advancement of technology in government, business, and education." . . . **Baldassare Di Bartolo,** Ph.D.'64, professor in the Physics Department at Boston College, reports that he was director of an advanced institute on "Disordered Solids: Structures and Process" in Erice, Italy from June 15 to 29.

X CHEMICAL ENGINEERING

To **Janos Beer,** professor of chemical and fuel engineering at M.I.T., an honorary doctorate from the Technical University for Heavy Industry, Budapest, Hungary.

Robert S. Davis, Sc.D.'55, has resigned from the post of president and chief executive officer of Power Recovery Systems, Inc., Cambridge. . . . **Noel Moore,** S.M.'58, since 1968 professor in the Department of Chemical Engineering at Rose-Hulman Institute of Technology, Terre Haute, Ind., has been chosen the new chairman of the department. . . . Professor **Clark K. Colton,** Ph.D.'69, in the department at M.I.T., received the $5,000 1986 Gambro Award for Blood Purification from the International Society of Blood Purification at the society's meeting in Osaka, Japan. Colton was cited for "original research . . . in membrane separation processes for blood . . . contributing to the development of extracorporeal blood purification systems including hemodialysis, hemofiltration, and plasmaphereis." . . . **Samuel W. Bodman III,** Sc.D.'65, president, chief operating officer and director of the Cabot Corp., Boston, has been elected a trustee of the Mitre Corp., Bedford, Mass.

Charles Kennedy Walker, S.M.'40, of Mission Viego, Calif., writes, "Just returned from Shakespeare Festival in Ashland, Oregon. Spend time computing to find out where the money went, traveling, and taking part in the activities of the local Optimist Club."

William J. Schmitt, Ph.D.'85, reports that after graduation he took a job as a scientist with Upjohn Co., Kalamazoo, Mich., in chemical process research and development. His major responsibility is to take a procedure for the synthesis of an organic compound, optimize the synthesis, then scale it up for production in a safe and cost-effective manner. Schmitt lives in Portage, Mich.

Roy N. Levitch, Sc.D.'66, writes, "After five years with Shell Oil's photovoltaic affiliate in Phoenix (Solavolt International), I've returned to Shell Oil as manager, international affairs—planning, with responsibility for U.S. informational services to the Royal Dutch/Shell Group of Companies. The job will get me to Cambridge and M.I.T. often!"

Robert B. Flanders, S.M.'58, of Sharon, Mass., writes a relaxed update: "Really, nothing new. Just enjoying my busy retirement."

Joseph P.P. Jones, Ph.D,'74, writes of his current activities: "vice-dean of research and graduate studies, Faculty of Applied Sciences at the Universite de Sherbrooke, Canada; member of the Conseil de Science et Technology of the province of Quebec; and associate editor of the *Canadian Journal of Civil Engineering*."

M. Lampkin

XI URBAN STUDIES AND PLANNING

W. Tod McGrath, who is starting his second year as a Ph.D. candidate in the Center for Real Estate Development at M.I.T., holds the $10,000 first prize in a real estate essay competition sponsored by the Shidler Group, a West Coast property management firm. The winning essay was a specialized study of the effect of real estate taxes on real estate investors.

William A. Cawley, S.M.'55, has been appointed director of the Gulf Coast Hazardous Substance Research Center at Lamar University, Beaumont, Tex. Cawley, noted for his experience in hazardous waste research administration, is a 20-year veteran with the United States Environmental Protection Agency Office of Research and Development. . . . To **Martha Lampkin,** M.C.P.'81, an associate of Sasaki Associates, Inc., Watertown, Mass., since 1985, a Division of Capital Planning and Operations Design Award for the University of Lowell Masterplan. Lampkin served as Sasaki's project manager and urban designer for the master plan study.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

Edward N. Lorenz, Sc.D.'48, retired to the rank of professor emeritus of meteorology at M.I.T. last July 1. Except for leaves of absence to the Lowell Observatory, University of California at Los Angeles, Norwegian Meteorological Institute in Oslo, and National Center for Atmospheric Research, Lorenz has been associated with M.I.T. continuously since receiving his doctorate. He is an expert in the dynamics of atmospheric circulations and holds three major awards for work in this field—the Symonds Gold Medal, the Rossby Research Medal, and the Meisinger Award. Lorenz was head of the Department of Meteorology from 1977 until its consolidation with earth sciences in 1985.

John M. Kirk, who founded his company, John M. Kirk Co., Malden, Mass., after studying meteorology at M.I.T., received an honorary doctor of laws degree from his undergraduate alma mater, Middlebury College, last May 24. Kirk has been involved with Middlebury for more than 50 years, including service as president of the Alumni Association, alumni trustee, charter trustee, and presently, college overseer.

XIV ECONOMICS

William D. Nordhaus, Ph.D.'67, is coauthor with three Yale University colleagues of *Toward a New Iron Age? Quantitative Modelling of Resource Exhaustion* (Harvard University Press, 1987). Using copper as an example and based on extensive computer modelling, the book suggests that resource exhaustion will eventually bring society to dependence on the three most abundant resources—iron, silicon, and aluminum. But the transition will be slow and economic disruption minimal.

Michael J. Piore, Mitsui Professor of Contemporary Technology at M.I.T., is among 1987-88

PHOTO: WALTER S. SILVER

"Socialistic Democracy" for China?

The problems sound very familiar—too few women students, inadequate facilities, too much specialization, a shortage of faculty . . .

But when Xie Xide, Ph.D.'51, talks about these issues, they have a context totally different from that in which any American college or university president operates. For Xide is president of Fudan University, Shanghai, spoken of as the "Harvard of China," and her task is to modernize her institution and help her country recover from the turmoil of the Cultural Revolution. She discussed university life in China in a lecture at Radcliffe last spring.

Xide studied physics at M.I.T.—she then took the name Hsi-Ten Hsieh Tsao—after completing her master's degree at Smith. She returned to China in 1951 to specialize in solid-state and semiconductor physics, and 27 years later was made Fudan's vice-president. Six years later, she became president, and when Smith gave her an honorary doctorate in 1981, Xide was characterized as "one of China's most distinguished leaders in education."

The nation's educational problems are legion. Only 2 million out of China's 400 million college-age young people go to school—far too few, said Xide. But facilities are inadequate for more. Furthermore, enrollment is unbalanced: too many students elect to major in engineering (30 percent or more), too few in science (6 to 8 percent), very few in law, finance, and management, and virtually none in economics, Xide said. Teaching in all fields is too narrow and specialized, and the only way to change that is to send more faculty overseas for training. There is a shortage of laboratory equipment, critical if the supply of scientists is to be increased.

On a U.S. tour last spring, Xie Xide, Ph.D.'51, president of Fudan University, Shanghai, spoke to a Radcliffe audience on China's educational problems. Xide's agenda for her institution, which is known as the "Harvard of China," is to help her country recover from the turmoil of the cultural revolution.

Sexual discrimination is not legal in China, but because of "social prejudice" only 10 percent of the country's professors and 12.6 percent of its Ph.D. candidates are women. Women comprise only 3.5 percent of the membership of the Chinese Academy of Sciences. At Xide's school, the proportion of women students is up from 25 percent in 1981 to 36 percent in 1986. But only 1 physics student in 10 is a woman.

Xide, who is a member of the Communist Party's central committee, said to solve these massive problems, China needs a "socialistic democracy—a government that can reduce the structural demands of the bureaucracy and increase freedom and flexibility." □

Phi Beta Kappa visiting scholars. On invitation from local PBK chapters, Piore will make two-day visits to colleges and universities to lecture and meet informally with students and faculty.

Professor **Morris Adelman** of M.I.T., who ranks among the world's leading petroleum economists, retired to the rank of professor emeritus last July 1. He has been at M.I.T. ever since receiving his doctorate at Harvard in 1948 and is the author of a number of controversial books and papers on world oil supply, demand, and economic issues.

Professor **Paul L. Joskow,** in the department at M.I.T., was elected a director of New England Electric System last April 28. At M.I.T. since 1972, Joskow has specialized in public utility regulation, industrial organization, and energy economics. . . . **Carliss Y. Baldwin** '72, has been appointed a full professor and granted tenure at the Harvard Business School. Baldwin joined the Harvard faculty in 1981 and has been the faculty coordinator for Ph.D. candidates in business economics studying finance. She is the author of numerous papers on the illiquidity and irreversibility of real capital decisions. Prior to joining the Harvard Business School staff, Baldwin was an assistant professor at M.I.T.'s Sloan School.

XV MANAGEMENT

James M. Utterback, Ph.D.'69, director of the M.I.T. Industrial Liaison Program, is the author of "Innovation and Industrial Evolution in Manufacturing Industries," the first article in a new collection published by the National Academy of Engineering. The book, *Technology and Global Industry: Companies and Nations in the World Economy* (National Academy Press, Washington, 1987), is based on papers given at a 1986 NAE conference symposium for which **Ann F. Friedlaender,** Ph.D.'64 (XIV), dean of the M.I.T. School of Humanities and Social Sciences, was an adviser.

To **Frank P. Davidson,** program coordinator for macroengineering research in the System Dynamics Group of the Sloan School, an honorary doctorate in humane letters from Hawthorne College, Antrim, N.H. Davidson was cited for his "public-spirited analysis of large-scale engineering systems and his leadership in the field of macroengineering."

Gordon F. Bloom and **Harlan Meal,** both senior lecturers in the Sloan School at M.I.T., retired to part-time assignments last July 1. Bloom, a specialist in marketing and legal affairs, especially of foods and beverages, came to M.I.T. in 1968; he had previously been an executive in food and department stores. Meal, trained in chemistry at Harvard, came to M.I.T. in 1976 to teach in the field of operations management; he had previously served as head of logistics systems at Arthur D. Little, Inc.

Arnaldo C. Hax, Sloan Professor of Management at M.I.T., is the editor of *Planning Strategies That Work* (Oxford University Press, 1987), the second in a projected "Executive Bookshelf" collecting major contributions to the *Sloan Management Review.* Among faculty and alumni authors in Hax's book are **Charles A. Berry,** S.M.'83 (VI), marketing director of Barr and Stroud, Ltd., a subsidiary of Pilkington Brothers; **David A. Garvin,** Ph.D.'79 (XIV), associate professor of business and administration at Harvard; **Modesto A. Maidique,** Ph.D.'70 (VI), President of Florida International University; **Edward B. Roberts,** Ph.D.'62 (XIV), Sarnoff Professor at M.I.T.; and **Edgar H. Schein,** Sloan Fellows Professor of Management at M.I.T.

George Warren Patterson III, S.M.'56, is working as a government computer specialist at the new Boston Federal Building. Patterson reports that he is enjoying his opportunities to return to the M.I.T. campus for courses, sports, and sailing. . . . **David J. Collins,** S.M.'59, resigned from the posts of chairman, president and director of Computer Identics Corp., Canton, Mass. . . . **Donald H. Peters,** Ph.D.'69, director of planning at EG&G, Inc., Wellesley, Mass., has been promoted to the rank of vice-president. . . . **John P. McNicholas, Jr.,** S.M.'79, formerly director of business planning, is currently vice-president—Business Planning and Development at the Trinova Corp., Maumee, Ohio. . . . **Ernest I. Glickman,** S.M.'64, has been promoted from executive vice-president—human resources to president and chief operating officer at Harbridge House, Inc., Boston, a subsidiary of Sears World Trade, Inc.

Harvey C. Jones, Jr., S.M.'80, has changed titles: from president and chief operating officer to president and chief executive officer at Daisy Systems Corp., Mountain View, Calif. . . . **Pierre De Weck,** S.M.'76, is currently senior vice-president and manager of the New York Branch of Union Bank of Switzerland; formerly he served as first vice-president. . . . **Zev J. Spiro,** S.M.'78, writes, "After settling into our new home in Forest Hills, N.Y., my wife Fran and I have started a family with a baby boy, Joshua Stephen." . . . **John R. Talbot,** S.M.'62, reports that he is retired and living in Westfield, N.J.: "I presently reside in the

PHOTO: LILIAN KEMP PHOTOGRAPHY

'Garden State.' It's not much of a garden, but in light of my studies of management planning where we studied 'Management by Objective,' I sometimes wonder at the planning capabilities of 'We the People' and their chosen leaders."

Steven R. Resnick, S.M.'73, writes from Great Neck, N.Y., that he is involved in a securities business, specializing in research, institutional marketing and financing small ventures. . . . **Shoichiro Matsubayaski,** S.M.'81, writes, "I have been in a leveraged buy-out business in the most livable city of Pittsburgh since 1985. Mitsui participated in the LBO Fund and I am representing Mitsui at MMC Group of Pittsburgh, an investment bank for the the Fund."

Reverend **George H. Smith,** '32, of Decatur, Ga., passed away on May 24, 1987.

Sloan Fellows

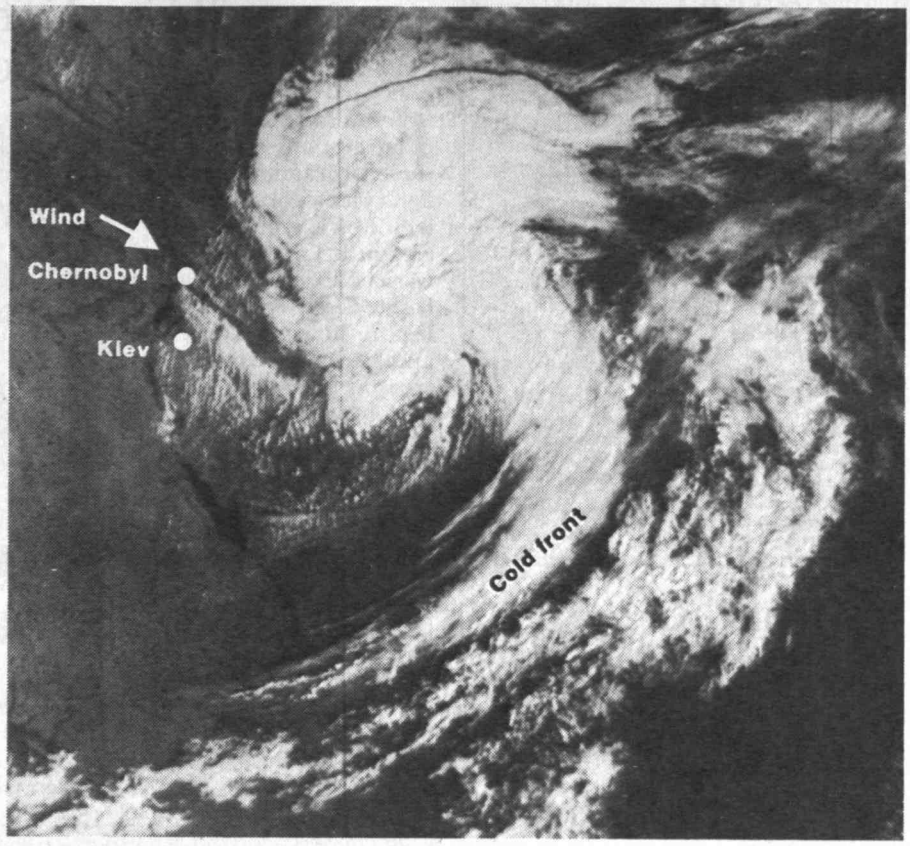
William J. Lhota, S.M.'78, senior vice-president of Columbus and Southern Ohio Electric Co., has been appointed to the board of directors of the Mount Carmel Health Foundation, Columbus, Ohio. Lhota, who lives in Worthington, Ohio, is also a trustee of Ohio Dominican College, the Ohio Public Expenditure Council, and the Columbus chapter of the American Red Cross. . . . **Robert W. Van Niel,** S.M.'72, has been elected assistant comptroller at Eastman Kodak Co., Rochester, N.Y. Van Neil joined the firm in 1958 and most recently was director of corporate accounting and financial reporting. . . . **Martin H. Flax,** S.M.'79, professor and chairman of the Human and Veterinary Pathology Department at Tufts University, Medford, Mass., has been named director of Syntro Corp., San Diego, Calif. . . . **Ormand J. Wade,** S.M.'73, formally president, chief executive officer and director of Illinois Bell Telephone Co. (a unit of Ameritech), is currently president of Ameritech Bell and director of Ameritech, Chicago. . . . . **John R. Smart,** S.M.'77, has been promoted from vice-president for manufacturing at AT&T's telephone equipment operations to senior vice-president of AT&T, New York, N.Y. . . . **Arthur J. Hedge, Jr.,** S.M.'73, president of I.B.M.'s Real Estate and Construction Division, Armonk, N.Y., has been named a vice-president of I.B.M. . . . **Joel D. Ware,** S.M.'67, retired on April 1 from the position of vice-chairman at Centrust Savings Bank, Miami, Fla.

Ronald L. Turner, S.M.'77, is currently president of the Electronic Division of the Singer Co., Stamford, Conn. Turner came to Singer from the Martin Marietta Corp., where he served as vice-president of Tactical Interdiction Systems, Orlando, Fla. . . . **Gary E. Frashier,** S.M.'70, has changed posts: from chairman and chief executive officer at Continental Water Systems Corp, San Antonio, Tex., to president and chief executive officer at Genex Corp., Gaithersburg, Md.

Robert C. Sprague, Jr., S.M.'58, of Williamstown, Mass., was killed in the crash of an airplane he was piloting on April 1, 1987. Sprague had joined the family's Sprague Electric Co. after World War II service in the Army Air Corps as lieutenant and flight instructor. He was later elected to the board of directors and then became senior vice-president of corporate services and aviation. Aviation, a passion throughout Sprague's life, led him to the formation of the Sprague Aviation Department, the company's avionics and maintenance facility. Sprague was also a life member of the Experimental Aircraft Association and the Antique Airplane Association, and he was a supporter of the Experimental Aircraft Association and Air Museum Foundation of Oshkosh, Wis. He was also a well-known restorer of vintage automobiles and published the *Steam Car Register*, "the only listing of all known steam cars throughout the world."

Senior Executives

Charles F. Bischoff, Jr., '74, was promoted early this year from senior executive vice-president to partner and president of Goodrich and Sherwood Co., Morristown, N.J. . . . **Patrick J. Scollard,** '76, executive vice-president—human resources at Chemical Bank (subsidiary of Chemical New York Corp.), New York City, now has added responsibilities as the bank's chief administrative officer.



Henry W. Brandli, S.M.'65, is chairman of the National Weather Association satellite meteorology committee and an expert on analyzing weather satellite photos. So when the Air Force saw something a little unusual in this picture, they asked Brandli what was going on. His answer: a "nuclear distrail," the first ever photographed. Distrails are not uncommon; they are the opposite of contrails—usually exhaust from planes or rockets dissipating clouds. But in this case, says Brandli, the picture was made over the Soviet Union on May 2, 1986, six days after the Chernobyl reactor meltdown. Ionized radioactive gases pouring from the ruptured reactor reacted chemically with water vapor to dissipate the clouds along a 30-mile-wide strip downwind of Chernobyl. The photograph confirms this phenomenon that had been predicted but never before observed.

XVI AERONAUTICS AND ASTRONAUTICS

Pan American Airways made two XVI graduates vice-presidents last March: **Robert W. Mann, Jr.,** S.M.'75, is vice-president for market information systems and **Donald S. Garvett,** S.M.'74, is vice-president for revenue management. Both were previously with Pan American—Mann as general manager of marketing, Garvett as general manager of revenue management.

K. Eric Drexler, S.M.'79, now a visiting scholar at Stanford, is the prophet of nanotechnology, a technology that proposes to combine electronics and biotechnology to produce tiny electronic devices in which logic functions are performed by the physical movements of atoms rather than electrons, as in today's microcircuits. This would eliminate an inherent limitation on the size and density of electronic systems—the heat generated by electronic circuit elements. So nanocircuits could be as small as a third of a nonometer (a billionth of a meter), Drexler told the Sixth Space Development Conference in Pittsburgh last spring. Circuits this small give computermakers the potential of creating computing devices with functional densities greater than the human brain, said Professor **Marvin Minsky** of the M.I.T. Artificial Intelligence Laboratory, who shared the platform with Drexler. And such devices, said Minsky, would be so powerful that they could assemble a space station without humans being present in space, simply by following commands radioed up from earth.

XVIII MATHEMATICS

Michael A. Arbid, Ph.D.'83, professor of computer science, neurobiology, and physiology at the University of Southern California, is co-editor of *Vision, Brain, and Cooperative Computation* (M.I.T. Press, 1987). Nineteen essays present current de-

Taking Number Theory To the Poker Table

If you're looking for an evening of inexpensive amusement, don't pick a poker game with M.I.T.'s Professor Nesmith C. Ankeny, warns Alex Beam of the *Boston Globe*. For in his leisure hours Ankeny takes number theory from classroom to professional poker table.

Ankeny is not a gambler: he's more interested in the game than in the winnings. Indeed, writes Beam, "with three mathematics degrees working for him at the table, one could argue that Ankeny isn't exactly gambling."

But winning isn't unimportant, because it's the criterion of success. Professor Robert C. Merton, Ph.D.'70, of the Sloan School, who's been a member of Ankeny's weekly poker game for 12 years, told Beam that Ankeny "over time has become the winner."

Mathematics Professor Nesmith C. Ankeny exhibits his poker prowess during an interview with Alex Beam of the **Boston Globe.**

Ankeny also won by writing a popular book on the subject—*Poker Strategy: Winning with Game Theory* (Basic Books, 1981)—containing tips on his favorite game, draw poker. Now Ankeny is at work on a book about casino poker games, for which he's done the research in Las Vegas while competing in nationwide draw poker tournaments. □

When to Hold 'em, When to Fold 'em

Poker tips from Nesmith C. Ankeny, professor of mathematics at M.I.T., as published in the *Boston Globe*:

□ Forget about luck. "A poker player considering luck in planning his moves is like the Pope contemplating marriage."

□ Always sit to the left of a conservative player. "When he's betting or raising, you'll have advance notice and can get out of his way."

□ Don't try to fill out a four-card straight. "There is an old saw about not drawing to an inside straight, but an open-ended straight is also a losing proposition."

□ Yes, Virginia, poker players do cheat. "The most common form of cheating is collusion between two players." Often, a cheater will remove a card from the deck, or "accidentally" leave a key card in the box. If you're suspicious, Ankeny suggests you count the discards in a game of draw. □

velopments in vision research, stressing contributions from neurophysiology, psychophysics, and computer science.

Institute Professor **Chia-Chiao Lin** of M.I.T., who held the James R. Killian, Jr., Faculty Achievement Award in 1981-82, retired to the rank of professor emeritus last July 1. During most of his years on the faculty starting in 1947, Lin has guided the development of applied mathematics while at the same time making significant research contributions to fluid mechanics. Other studies and consulting have been in superfluid helium and topics in astrophysics.

Gary R. Jensen, '63, professor of mathematics at Washington University, St. Louis, Mo., is co-author of *Differential Systems and Isometric Embeddings*, published by Princeton University Press. The book explores the fundamental role of the characteristic variety in the general theory of geometric problems and explains the general theory "in a relatively quick and concrete manner," says the publisher.

Carolyn L. Schroeder, Ph.D.'83, has been appointed assistant professor of mathematics at the University of Lowell, Mass. Schroeder was formerly affiliated with Tillinghast, Nelson, and Warren, Kansas City.

TECHNOLOGY AND POLICY PROGRAM

Robert Chen, S.M.'82, is now an assistant professor at Brown University. . . . **Shashi K. Sharma,** S.M.'78, has recently taken over as the head of the Central Planning and Control Department for Buckau Wolf Ltd., India, and is working on issues of technology choice. . . . **Steve Korthals-Altes,** S.M.'86, is working for the United States Office of Technology Assessment, Washington, D.C.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139

PHOTO: BOSTON GLOBE LIBRARY

ALLAN J. GOTTLIEB, '67

Seeking the Constants in the Physical Constants

Since this is the first issue of a new academic year, I once more review the ground rules under which this department is conducted.

In each issue I present five regular problems (the first of which is chess, bridge, or computer-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later one submitted solution is printed for each problem; I also list other readers whose solutions were successful. For example, solutions to the problems you see below will appear in the February/March issue. Since I must submit that column sometime in November, you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

For "speed" problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, the solutions to the issue's "speed" problems are given below. Only rarely are comments on "speed" problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes I go back into history to republish problems that remained unsolved after their first appearances.

Problems

OCT 1. Lawrence Kells reports that a friend of his once held

♠ 4 3 2
♥ 4 3 2
♦ 4 3 2
♣ 5 4 3 2

Despite the lack of power, he took five tricks in his own hand. Nobody made any illegal plays. What was the deal and how did the play go?

OCT 2. Hy Tran wants you to show that for k, r, and positive integers the expression

$$\sum_{k=1}^{r-1} \frac{r!n^k}{k!(r-k)!}$$

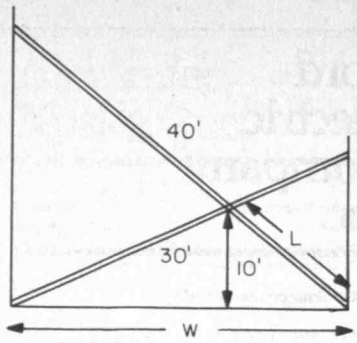
is always even—i.e., an integral multiple of 2.

OCT 3. The following problem first appeared in *Computers and People* in 1985. A "numble" is an arithmetical problem in which digits have been replaced by capital letters; there are two messages, one which can be read right away and a second one in the digit cipher. The problem is to solve for the digits. Each capital letter in the arithmetical problem stands for just one digit 0 to 9. A digit may be represented by more than one letter. The second message, expressed in numerical digits, is to be translated (using the same key) into letters so that it may be read; but the spelling may use puns or deliberate (but evident) misspellings, or may be otherwise irregular, to discourage cryptanalytic methods of deciphering.

```
          T H E
    ×     W O L F
    ---------------
        K T L O
      E W T F
    S W E W
  H H W L
  ---------------
= W L I W O O O
```

OCT 4. Here is a ladder problem from Joseph Molitoris and George Butwin. It looks familiar so I would not be surprised to hear that a similar if not identical problem appeared in *Puzzle Corner* ten or fifteen years ago:
Given an alley of width W. Two ladders of length 40 ft. and 30 ft. are laid against opposite walls. They intersect 10 ft. above the ground. Find W and L, the width and one of the lengths of intersection. (*See diagram next page.*)

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.



OCT 5. Oren Cheyette has a problem concerning the first digit of various physical constants. The answer may surprise you. It surprised me:
Suppose you take a table of physical constants expressed in scientific notation (e.g., the speed of light is 2.998×10^8m/s) and construct a histogram of the first digits of their mantissas (e.g., 2, for the speed of light). In other words, count how many times each of the digits 1 to 9 occurs as the leading digit. What functions *a priori* do you expect to best fit this histogram? That is, for a random physical constant, what is the probability that its leading digit is n?

Speed Department

SD 1. Jim Landau wants to know why for any x between 0 and $\pi/2$ the sequence
x, cos(x), cos(cos(x)), cos(cos(cos(x))), . . .
converges to .739085 . . .

SD 2. Our last problem is from Harry Zaremba:
Let the decimal system numbers 31, 331, 3331, . . . be represented by the shorthand symbol 3_k1 in which the subscript k = 1, 2, 3, . . . signifies the number of the threes to the left of the one. What is the smallest value of k for which the number 3_k1 is composite? What are the number's prime factors?

Solutions

M/J 1. Construct a hypothetical bridge hand that contains the maximum possible number of finnesses, all of which would be successful. Consider spades as trump.

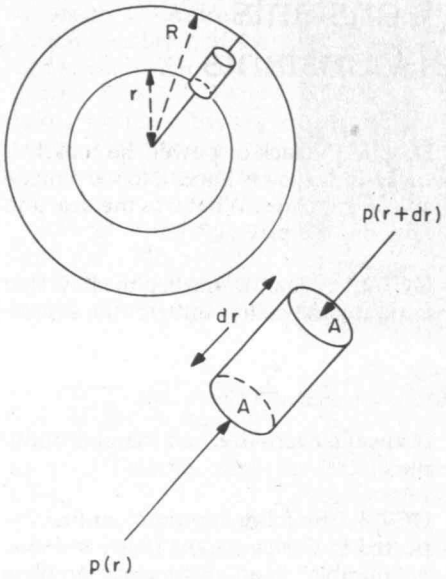
The following solution is from Winslow Hartford: I come up with 9 finesses. It's easy to plan the hand so N-S make either 7 spades or 7 no-trump. One entry is provided by the opening lead; the remaining 8 entries are readily available through winning finesses and 4 aces. The opening lead is immaterial.

	♠ --- ♥ ---- ♦ A Q 10 ♣ A Q 10	
♠ -- ♥ --- ♦ K J 9 - ♣ K J 9 -		♠ K J 9 7 ♥ K J 9 ♦ --- ♣ ---
	♠ A Q 10 8 ♥ A Q 10 ♦ --- ♣ ---	

Also solved by the proposer Jim Landau, who reports that Allen Beadle, mentioned in the original statement of **M/J 1,** is also the (heretofore) anonymous slide rule expert who "computed" $.99^{100}$ mentally. Moreover, it was Beadle who told Landau the Zorn's Lemmon riddle.

M/J 2. What is the pressure due to gravity at the center of a spherical heavenly body of uniform density, mass M, and radius R?

The following solution is from Dennis White: Consider a small right cylinder with its axis placed radially within the spherical body:



The gravitational force on it is provided by the central sphere "underneath" with radius *r* (outer layers have a net zero attraction on it), and this sphere's mass can be considered to be concentrated at 0. Taking the cylinder to be a point mass, this force is
$Fg = -G[(4/3\pi r^3\rho)(Adr\rho)]/r^2 = -4(\pi G\rho^2 Ardr)/3$
where ρ is the body's density. For the cylinder to be at equilibrium, this must be matched by the buoyant force provided by the pressure differential $dp = p(r + dr) - p(r)$. (The pressure is a function of r alone by symmetry.) This force is
$F_b = Ap(r + dr) - Ap(r)$
$= A [p(r + dr) - p(r)]$
$= Adp$
Setting $F_g = F_b$, we have
$-4(\pi G\rho^2 Ardr)/3 = Adp$, or
$dp/dr = -4[(\pi G\rho^2)r]/3$.
Solved, with the boundary condition $p(R) = 0$, this gives
$p(r) = 2\pi G\rho^2(R^2 - r^2)/3$
or substituting
$\rho = M/(4/3)\pi R^3$
$p(r) = (3/8)G(M^2/\pi R^6)(R^2 - r^2)$,
and so p(0), the pressure at the center, is
$p(0) = (3/8)G(M^2/\pi R^6)(R^2 - r^2) = (3/8)G(M^2/\pi R^4)$.

Also solved by Matthew Fountain, Winslow Hartford, and the proposer, Bruce Calder.

M/J 3. Find nine single-digit numbers with sum 45 and product 362880. One solution is (1,2,3,4,5,6,7,8,9).

The following solution is from Bob Marshall, who says "thanks for publishing this puzzle that I could solve":
Start by observing that all such sets must be assembled from numbers included in the prime factorization of 362880 with the optional addition of one or more 1s. (Note that the starter solution included a 1; therefore this must be permitted.) The prime factorization of 362880:
$363880 = 2^7 \times 3^4 \times 5 \times 7$.
Note immediately that each solution must include the single digit numbers 5 and 7, because these factors must be included to achieve the product and any multiple of either of these numbers is not a single digit. The case of whether or not a 1 is included in the solution will be dealt with specially because the 1 does not change the product but will change the sum. For the case of no 1s the factors $2^7 \times 3^4$ must be distributed among 7 single digit numbers. These are constructed by inspection as follows:

Digits 1 2 3 4 5 6 7 8 9	Sum
9 9 8 2 2 2 2 5 7	46
9 9 4 4 2 2 2 5 7	44
9 8 6 3 2 2 2 5 7	44
9 8 4 3 3 2 2 5 7	43
9 6 6 4 2 2 2 5 7	43
9 6 4 4 3 2 2 5 7	42
9 4 4 4 3 3 2 5 7	41
8 8 3 3 3 3 2 5 7	42
8 6 6 3 3 2 2 5 7	42
8 6 4 3 3 3 2 5 7	41
8 4 4 3 3 3 3 5 7	42
6 6 6 6 2 2 2 5 7	42
6 6 6 4 3 2 2 5 7	41
6 6 4 4 3 3 2 5 7	40
6 4 4 4 3 3 2 5 7	39

As can be seen from the Sum column none of these sets of single-digit numbers has the required sum. For the case with a single 1 the factors $2^7 \times 3^4$ must be distributed among six single-digit numbers. These are constructed by inspection as follows:

Digits 1 2 3 4 5 6 7 8 9	Sum
9 9 8 4 2 2 1 5 7	47
9 9 4 4 4 2 1 5 7	45
9 8 8 3 3 2 1 5 7	46
9 8 6 6 2 2 1 5 7	46
9 8 6 4 3 2 1 5 7	45
9 8 4 4 3 3 1 5 7	44
9 6 6 4 4 2 1 5 7	44
9 6 4 4 4 3 1 5 7	43
8 8 6 3 3 3 1 5 7	44
8 6 6 4 3 3 1 5 7	43
8 6 6 6 3 2 1 5 7	44
6 6 6 6 4 2 1 5 7	43
6 6 6 4 4 3 1 5 7	42

In this case there are two solutions—the combinations: 1, 2, 4, 4, 4, 5, 7, 9 and 9; and 1, 2, 3, 4, 5, 6, 7, 8 and 9. This latter solution is the "given" solution and my method would be proved nonexhaustive if it failed to find this solution. For the case with two 1s, the factors $2^7 \times 3^4$ must be distributed among five single-digit numbers. These are constructed by inspection as follows:

Digits 1 2 3 4 5 6 7 8 9	Sum
9 9 8 8 2 1 1 5 7	50
9 9 8 4 4 1 1 5 7	48
9 8 8 6 3 1 1 5 7	48
9 8 6 6 4 1 1 5 7	47
8 6 6 6 6 1 1 5 7	46

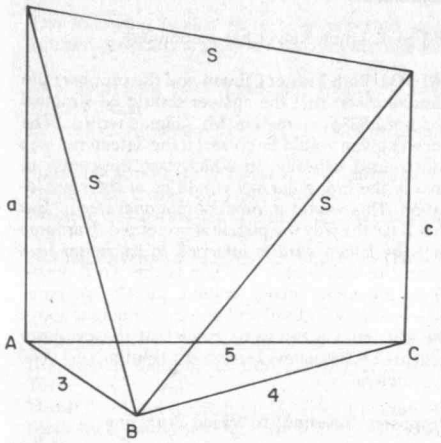
Thus there are no solutions for the case of two 1s. For the case with three 1s the factors $2^7 \times 3^4$ must be distributed among four single-digit numbers. However, this cannot be done as any combination of those factors distributed among four numbers yields at least one two-digit number. Therefore the search for solutions is complete. To recap, the two solutions are:
1 2 3 4 5 6 7 8 9
1 2 4 4 4 5 7 9 9

Also solved by Thomas Stowe, Avi Ornstein, Mike Gennert, Michael Jung, Alan Taylor, Dick Robnett, James Landau, John Woolston, Larry Bell, Matthew Fountain, Winslow Hartford, Ken Rosato, and Steve Feldman.

M/J 4. Find the axes of the largest (in area) ellipse that can be inscribed in a triangle having sides of length 3, 4, and 5 inches.

The following solution is from the proposer, Matthew Fountain:

The major and minor axes are 2.93986 and 1.57110. When the 3,4,5 triangle is viewed from an angle that makes it appear to be equilateral, the maximum area ellipse must appear as a circle. The foreshortening takes place in the direction of the major axis of the ellipse, with no foreshortening in the direction of the minor axis, so it may be concluded that the angle of view does not affect the ratio of apparent area of ellipse to apparent area of triangle. If an ellipse does not appear as a circle when the triangle appears equilateral, it follows that if the ellipse is viewed as a circle, the triangle would then appear not an equilateral triangle, implying that the ratio of ellipse area to triangle area was smaller than the previous case. An equilateral triangle is the smallest triangle circumscribing a circle.



Similarly, a proper-size equilateral triangle can be foreshortened into a 3,4,5 triangle. The figure above shows such an equilateral triangle with sides of length S, tilted so that its projection on a plane is the 3,4,5 triangle ABC. One vertex is the distance a above A, one vertex is the distance c above C, and the remaining vertex lies in the plane at B. S is found by writing $a^2 = S^2 - 3^2$, $c^2 = S^2 - 4^2$, and $(a-c)^2 = S^2 - 5^2$ and solving for S. The elimination of a and c results in the equation

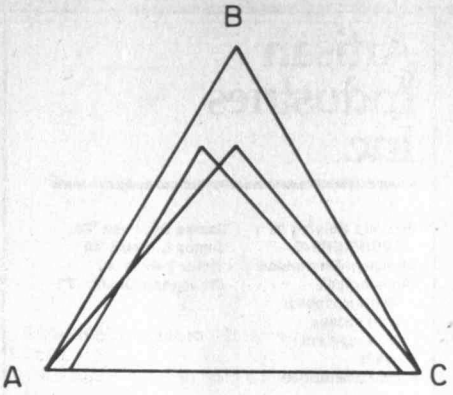
$3S^4 + 100S^2 + 24^2 = 0$,

with the solution $S = 5.091984$. The altitude of the equilateral triangle is $(S/2)\sqrt{3} = 4.409787$ and the diameter of the inscribed circle is two-thirds the altitude—that is, 2.939858. This is also the major axis of the ellipse in the 3,4,5 triangle. The respective areas of the equilateral triangle and the 3,4,5 triangle are $(5.091984)(4.409787)/2 = 11.227282$ and $(3)(4)/2 = 6$. The minor axis of the ellipse is $(2.9398858)(6)/11.227282 = 1.571096$.

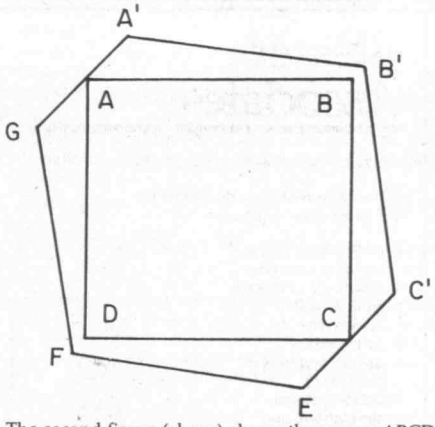
Also solved by Norman Wickstrand, Winslow Hartford, Edward Dawson, and Dennis White.

M/J 5. Through which regular polyhedra can one carve a hole such that another regular polyhedron of the same size and type can pass? For example, clearly a cube with unit edge can pass through a suitably cut hole in another cube with unit edge.

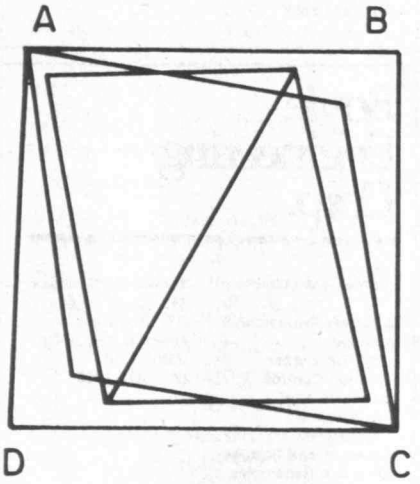
The following solution is from Matthew Fountain: The regular tetrahedron, the cube, and the regular octahedron can each be passed through a hole in a polyhedron identical to it. The dodecahedron and icosahedron cannot. One procedure to determine when this is possible is to view each polyhedron from various angles and compare silhouettes. When one silhouette can fit into another, it is possible. If the polyhedron is rotated, it is possible to obtain both silhouettes as projections of the polyhedron on one plane, in positions that assist comparisons between them. As a regular polyhedron rotates, its vertices move in the surface of a sphere, their projections on a plane moving to and from the circumference of a circle. The dodecahedron and icosahedron have so many vertices that no matter what axis of revolution is chosen, the vertices of their silhouettes are never going outward to the circle at the same time. This would be necessary for one silhouette to fit within another, as there is not chance for any appreciable rotation of one silhouette allowing it to fit into another.



The figure above shows equilateral triangle ABC as the silhouette of the regular tetrahedron projected upon a plane parallel to one face. Tilting the tetrahedron backward shortens its silhouette as shown. Then rotating this tilted tetrahedron about a vertical axis through the center of its bottom edge shortens the bottom edge of the silhouette. The figure exaggerates the foreshortening that occurs in order to show it more clearly. The last silhouette will fit in ABC when raised slightly.



The second figure (above) shows the square ABCD as the silhouette of a cube projected upon a plane parallel to one face. Rotating the cube about its center on an axis parallel to AC produces the silhouette AA'B'C'EFG. As EF and GH are perpendicular to AC, the first silhouette will fit in the second when rotated slightly.



The third figure (above) shows the square ABCD as the silhouette of a regular octahedron projected upon a plane parallel to four edges. Rotating the octahedron about its center on an axis parallel to AC produces the diamond-shaped silhouette extending between A and C. An additional rotation of the octahedron about its center on an axis parallel to BD produces a silhouette lying within the ABCD.

Also solved by Winslow Hartford.

Better Late Than Never

JAN SD1. Sidney Williams has responded.

JAN 3. Dennis White notes that an unstated requirement was that the i^{th} term uses the digit i.

F/M 2, 3, 4. Winslow Hartford has responded.

APR 3. Joseph Muskat, Naomi Markovitz, and Winslow Hartford have responded.

APR 4. Naomi Markovitz and Winslow Hartford have responded.

APR 5. Joseph Muskat and Winslow Hartford have responded.

M/J SD1. Linda Kalver has responded.

M/J SD2. Both Turner Gilman and the proposer Jim Landau assert that the answer should be 4 meters and not 2.8284 . . . meters. Mr. Gilman writes: "The answer given would be correct if the 'lateen rig' was constructed logically, in which case the center of area of the triangular sail would be at the mast location. This would minimize rotational forces. But that is *not* the way the puzzle is presented. I 'assume that the lateen yard is attached to its center to a mast 2 meters high.' The key is the word *center*. There are some details omitted, i.e. the clearance between deck and sail and any excess height above the sail, but on the same basis that the proposer gets his 2.8284 meters I arrive at a solution of 4.0000 . . . meters!"

Proposers' Solutions to Speed Problems

SD 1. You are just using an iterative method to find the solution to $\cos(x) = x$.

SD 2. All the numbers 3^k1 are prime for k equal to the consecutive numbers 1 to 7, inclusive. The smallest value of k for which the number is composite is 8:
$3_81 = 333,333,331 = 17 \times 19,607,843$.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Mrs. Benjamin W. Pepper, '09; August 15, 1983; Boston, Mass.
Edward C. Anderson, '19; July 25, 1985; Richmond, Va.
Harold B. Caldwell, '20; May 7, 1987; Sarasota, Fla.
Hilliard D. Cook, '21; April 29, 1987.
Munroe C. Hawes, Sr., '21; June 20, 1987; Sea Girt, N.J.
Nathan Cherniack, '22; April 2, 1986; Kew Gardens, N.Y.
Edward C. Keane, '22; June 18, 1987; Cambridge, Mass.
Leland M. Rice, '22; June 13, 1986; Montclair, N.J.
Jonathan Y. Ballard, '23; June 22, 1987; Fort Worth, Tex.
Olcott L. Hooper, '23; June 25, 1987; Vershire, Vt.
Malachy J. Naughten, '23; July 5, 1987; Alto Loma, Calif.
Wilson Potter, Jr., '23; April 26, 1987; Riverside, Ga.
John T. Blake, '24; June 26, 1987; East Orleans, Mass.
Avery A. Morton, '24; March 25, 1987; Watertown, Mass.
Hugh H. Brenan, '25; April 10, 1987; Seminole, Fla.
Maurice C. Conkey, Jr., '25; May 17, 1987; Santa Barbara, Calif.
Alfred Kullman, '25; February 10, 1987; Glenview, Ill.
John Magee, '25; June 22, 1987; Springfield, Mass.
John F. Wegforth, '28; April 1, 1986; La Mesa, Calif.
Daniel J. Collins, '29; March 19, 1987; Whiting, N.J.
Robert S. Hatcher, '29; June 12, 1985; Monterey, Calif.
Emery M. Low, '29; June 3, 1987; Baltimore, Md.
Henry S. Bean, '30; January 1987; Remsenburg, N.Y.
Willard B. Paine, Sr., '30; May 27, 1986; Hermosa Beach, Calif.
Dick C. Holihan, '31; March 21, 1987; Flint, Mich.
Robert E. Arnold, '32; March 11, 1987; Schenectady, N.Y.
James A. Beam, '32; March 13, 1987; Mt. Vernon, Ohio.
G. Ross Lord, '32; January 16, 1986; Toronto, Canada.
Morris I. Poze, '32; 1983.
David R. Pryde, '32; May 19, 1987; Hendersonville, N.C.
George H. Smith, '32; May 24, 1987; Decatur, Ga.
John L. Walker, '32; October 4, 1972; Pearland, Tex.
James E. Norcross, '33; June 5, 1987; Wawa, Penn.
Robert G. Butler, '34; February 21, 1987; Bridgeport, Conn.
Howard L. Reichart, Jr., '34; May 16, 1987; Mystic, Conn.
Willard B. Simonds, '34; July 7, 1987; Gulfport, Fla.
Jack L. Stauton, '35; May 10, 1987; Westport, Conn.
David A. Blanton, Jr., '36; December 12, 1985; St. Louis, Mo.
John K. Jacobs, '37; February 13, 1985; Richmond, Calif.
George O. Knapp, '37; May 7, 1987; Darien, Conn.
James W. Osmun, '37; September 1982; Boca Raton, Fla.
Sidney F. Mack, '38; May 18, 1987; Pine Grove Mills, Penn.
E. Roger Kirk, '40; December 1986; Toledo, Ohio.
Richard H. Engelman, '41; June 5, 1987; Cincinnati, Ohio.
Theodore P. Nordin, Jr., '42; June 28, 1987; Lynn, Mass.
Clinton C. Kemp, '43; May 22, 1987; Toronto, Canada.
John T. McCabe, '47; February 14, 1987; Seattle, Wash.
Dorothy W. Pelzer, '50; 1986.
Mihran Ayvazian, '51; July 5, 1987; Arlington, Mass.
William G. Blanding, '53; May 3, 1987; Norwalk, Conn.
George D. Rivers, '54; May 1987.
William L. Veeck III, '58; January 21, 1985; Kapaa, Hawaii.
Dennis L. Hinrichs, '64; May 6, 1987; Nahant, Mass.
David R. McMillan, '67; June 27, 1987; Winchester, Mass.
Charles T. Lederer, '74; May 5, 1986; Tucson, Ariz.
Dwight D. Gibson, '75; June 5, 1987; Southfield, Mich.
Ashok Khanna, '75; December 17, 1985; Pune, India.
Carlos L. Vila, '78; May 16, 1986; Coatesville, Penn.

DONOR'S PROFILE:

MRS. RAYMOND A. ST. LAURENT

HOME: Manchester, Connecticut and Center Lovell, Maine

CAREER: Raymond A. St. Laurent earned a bachelor's degree from MIT in 1921 and a master's in 1922, both in chemical engineering. Before his death in 1971, he was vice president of the Rogers Corporation, an engineering plastics company in Rogers, Connecticut. He also served as president of MIT's Class of 1921 for fifty years, and he and Mrs. St. Laurent were involved in a variety of alumni activities. Mrs. St. Laurent, now in her late eighties, continues their commitment to MIT.

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Photo: Bradford F. Herzog

into practical design requirements.

This approach works well in Japan, where many engineers do not switch firms. But with a frequent turnover of engineers, most U.S. companies are unwilling to make such a heavy investment in training. In the United States the universities must be the source of engineering design education.

Computer-aided design cannot substitute for a thorough design education.

Solving the Problem

Leaders in U.S. industry, government, and academia are starting to recognize that the deemphasis of design is damaging the country's engineering enterprise. Perhaps the clearest acknowledgment of the problem has come from the NSF. Its recently initiated program of Engineering Research Centers, located at universities, recognizes that to be more competitive internationally, U.S. engineers must improve their ability to design. For instance, Carnegie-Mellon University recently won a $14.9 million grant through this program to undertake a major expansion of its design center, which it started in 1974. To date, NSF has committed more than $200 million to the engineering centers program.

Some universities have been taking action as well. Most schools are offering senior engineering students "capstone" courses that consist of designing a project. In 1984 M.I.T.'s Mechanical Engineering Department formalized its design program by establishing the Martin Center for Engineering Design, where students both design and conduct research on design methods. M.I.T. and other schools are also considering emphasizing design through mechanisms such as new faculty chairs and student fellowships.

These programs, pronouncements, and intentions are positive signs. Taken alone, however, they cannot make up for the lack of design expertise among graduating engineers. All engineering schools need to systematically change their programs to restore the balance between engineering science and design. This should be done through faculty appointments, since the nature of the curricula and the quality of courses depends largely on the composition of the faculty in a given department.

The College of Engineering at the University of Delaware is planning to do just that. The school's approach consists of two phases. The starting point is the implementation of the ABET requirements in spirit as well as in letter. The first phase retains the ABET-approved curricula and seeks to ensure that qualified faculty are available to teach the design courses. In addition, the engineering departments are beginning to require that senior undergraduates complete a capstone design course. Toward the end of the senior year, each student must submit a report containing a description of the project, background information, drawings, analyses, and the proposed method of construction or manufacture. Students may design anything from turbines to bridges to computers. Each project will be supervised by a design professor and assistants.

The second phase will extend design activities into the graduate programs and establish design-oriented master's degrees. Unlike current M.S. programs that emphasize engineering sciences, the new degrees will stress design methods, case studies of successful designs, examinations of engineering failures, and new tools such as computer-aided design and manufacturing and artificial intelligence.

The existing Ph.D. programs are research degrees, and so their emphasis on science and mathematics

is appropriate. However, like the M.S. degrees currently offered, these awards should be termed engineering-science degrees to distinguish them from design-oriented engineering programs.

To help carry out this program, the university will appoint appropriate design faculty members as needed. Increases will be gradual, with job openings filled as required. The desirable ratio will depend on the department. For example, as part of the first phase in civil and mechanical engineering, the goal would be one design professor for every four in the engineering sciences. For the second phase, a ratio of one design professor to two or three in engineering sciences seems appropriate.

Many industrial engineers could apply their decades of experience in teaching.

A candidate for a full professorship in design would be an outstanding designer from industry with 20 to 30 years of experience. A doctoral degree should not be required, although knowledge of the latest technical developments should. A design professor should follow design trends in industry and continue to develop design expertise.

Some current faculty members may argue that qualified engineers are not likely to leave industry for often lower-paying academic positions. On the contrary, many senior engineers in industry may find a professorship appealing, as it would give them time to think and experiment and the opportunity to summarize design experiences accumulated over decades. These are advantages that, for some, may be worth a salary cut. And to make a faculty position more attractive, tenure could be granted at the start of full-time teaching.

Those who oppose a change in curricula also argue that the design experience of professors who come from industry may quickly become obsolete. But while designs for many structures, mechanical devices, and systems have been changing rapidly, basic design knowledge changes very little. This element of a student's education will outlast training acquired on the job.

An additional benefit to appointing experienced engineers to design professorships is that they will ease the faculty shortage in engineering. The pool of potential applicants for faculty positions will increase enormously if senior industry designers are included.

Many recent federal programs that are funding R&D to improve the competitiveness of U.S. industry are at this point more likely to help our competitors. The programs' results will be accessible to other countries that have design engineers ready to put them into practice.

To help our industries, the government should modify the funding processes that created the present situation in engineering education. Agencies such as the NSF, NASA, Air Force Office of Scientific Research, Office of Naval Research, and Army Research Office should allocate a small fraction of their research grants to qualified engineering-design professors who want to develop novel designs or write practical design textbooks. If these agencies can convince the universities that they will continue funding these types of design research, the universities will likely begin appointing experienced design engineers as professors.

The steps we suggest for universities and federal agencies are not radical. Yet, if adopted, they will create a balance between the engineering specialties that in the long run will contribute substantially toward improving the competitiveness of U.S. industries. □

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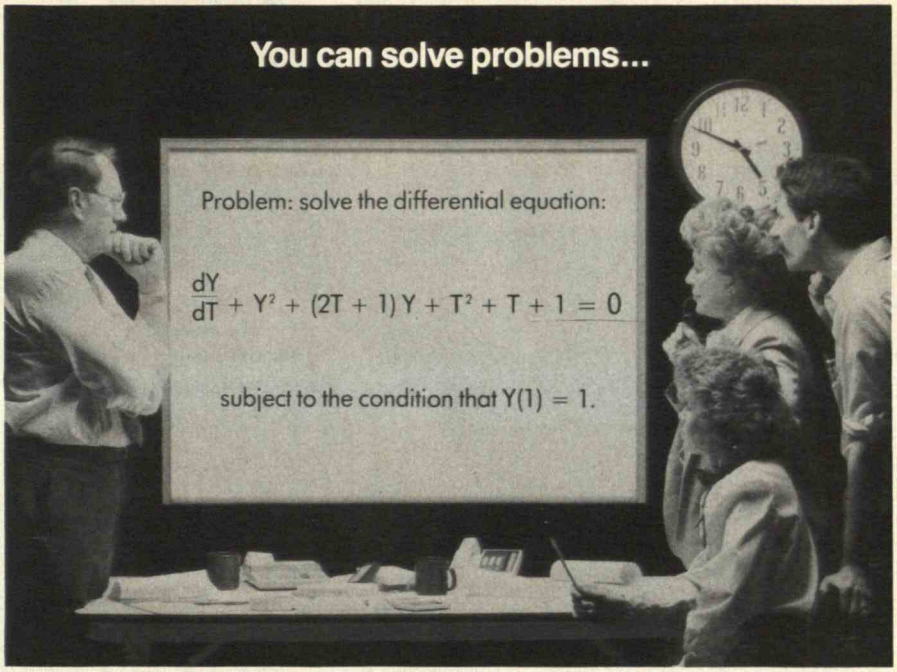

Symbolically...

```
(C1) DEPENDS(Y,T)$
(C2) DIFF(Y,T)+Y^2+(2*T+1)*Y+T^2+T+1;
```

$$(D2)\quad \frac{dY}{dT} + Y^2 + (2T+1)Y + T^2 + T + 1$$

```
(C3) SOLN:ODE(D2,Y,T);
```

$$(D3)\quad Y = -\frac{\%C\,T\,\%E^T - T - 1}{\%C\,\%E^T - 1}$$

```
(C4) SOLVE(SUBST([Y=1,T=1],D3),%C),NUMER;
(D4)    [%C = 0.5518192]
(C5) SPECIFIC.SOLN:SUBST(D4,SOLN);
```

$$(D5)\quad Y = -\frac{0.5518192\,T\,\%E^T - T - 1}{0.5518192\,\%E^T - 1}$$

and Numerically.

```
(C6) FORTRAN(D5)$
      Y = -(0.5518192*T*EXP(T)-T-1)
     1     /(0.5518192*EXP(T)-1)
```

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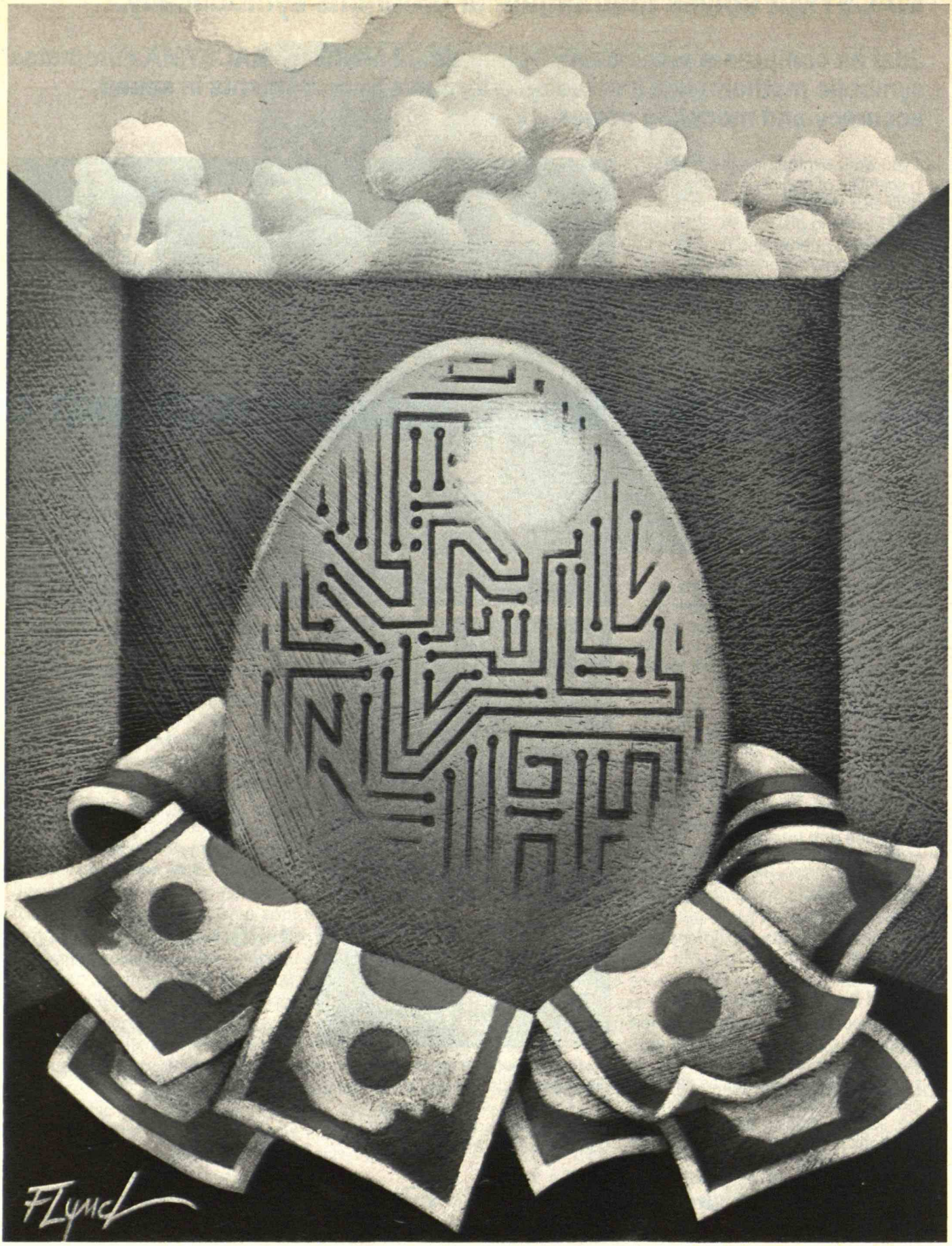


ILLUSTRATIONS: FRED LYNCH

HOPE OR HYPERBOLE?

High Tech and Economic Development

Governments seek high-tech industries to create jobs and boost local economies, but there are limits to what public policy can accomplish.

THE ALLURE OF replicating California's Silicon Valley, Massachusetts's Route 128, and other high-tech centers has spawned a dizzying array of government policies intended to attract growing industries and nurture new firms. Hundreds, if not thousands, of communities and all 50 states are tying at least part of their economic future to high technology. By the end of 1985, a total of 35 state programs to recruit advanced technology industry were in place, compared with only 4 in 1979.

In the upcoming 1988 presidential campaign, entrepreneurship is the buzzword as candidates of both parties propose ways to foster development. Republicans are sticking to the laissez-faire approach of lower taxes and deregulation, while Democrats are pushing government activism, including public-private partnerships to stimulate fledgling companies. And the high-tech success of Massachusetts has put the campaign of Gov. Michael Dukakis into the limelight.

Many of these programs, proposals, and platforms are doomed to failure. Public programs can foster economic growth, but only if they consider the unique local conditions that bring about success.

The world's most ambitious high-technology development endeavor is Japan's Technopolis Concept, a plan to build 19 high-tech cities and link them to Tokyo by bullet trains. Japan's Ministry of Trade and Industry (MITI) selects the locations for these science cities. It looks for good transportation facilities; an integrated complex of industrial, academic, and residential areas; a pleasant living environment; and access to a "mother city." Tsukuba Science City, conceived in the 1960s and now home to 2 universities, 50 national research institutes, and over 11,000 researchers and staff, is in part a prototype technopolis.

BY EDWARD J. MALECKI

In the United States, without strong central government support or guidance, the prospect of reproducing the Silicon Valley or Route 128 technopolises seems unlikely. Communities with existing high-tech concentrations have a huge advantage over areas seeking their first piece of the action. It is clear that success breeds success by providing a critical mass of workers, researchers, investors, and supporting businesses and services.

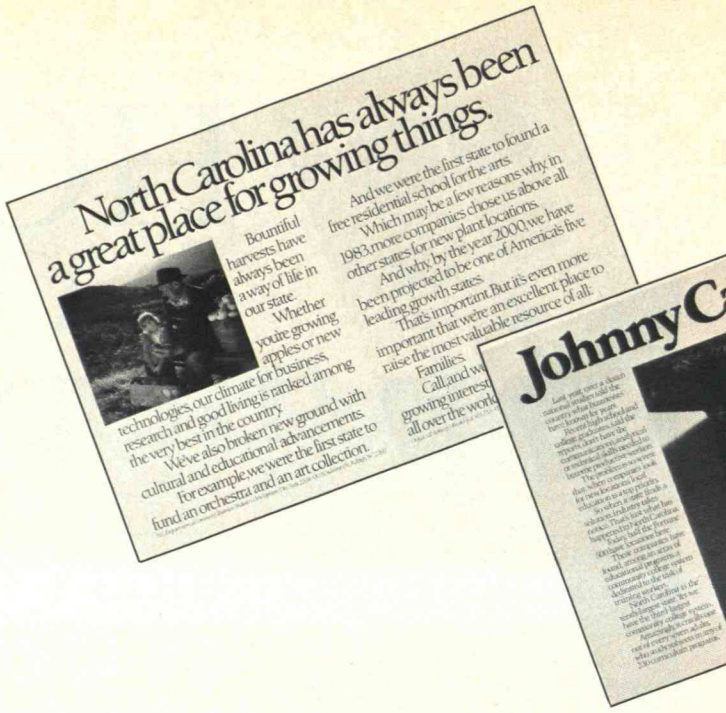
The high-tech route to economic development is susceptible to social control. The fundamental dilemma for states and communities is that policy can't influence all variables—and most are alterable only in the long run and after substantial investment. Pools of professional and technical employees and employers, bastions of top-rank university research, and sources of seed and venture capital are critical for high-tech industry. None are created quickly.

Moreover, high-technology industry is misunderstood and probably overrated as a generator of jobs. The number of jobs it produces *directly* is relatively low. The Department of Labor defines high-tech industries as those employing a high proportion of engineers and scientists. Under that definition, high-tech employment is unlikely to exceed 10 percent of the U.S. work force. Only a few of the service industries coming to dominate the U.S. economy are high-tech; computer software and information processing are at the top of that short list.

At the same time, high-tech is the most probable source of innovations, successful entrepreneurs, new firms, and new industries. Through this indirect and more long-term route, high tech *is* an important employment generator. For example, high tech has spawned industries such as electronics, computers, and biotechnology that employ thousands of people. However, many of the jobs are semi-skilled.

Since branch plants have less need for skilled workers and large research components, they are more prone to move or close. Thus, farsighted industrial recruitment encourages firms to establish mainly R&D facilities rather than manufacturing plants. R&D labs employ better-paid, professional workers and require larger capital investments. This makes them less likely to close during economic downturns or to move on short notice to lower-wage sites.

EDWARD J. MALECKI is professor of geography at the University of Florida in Gainesville. He has written widely on economic development and on the geography of R&D and high technology.



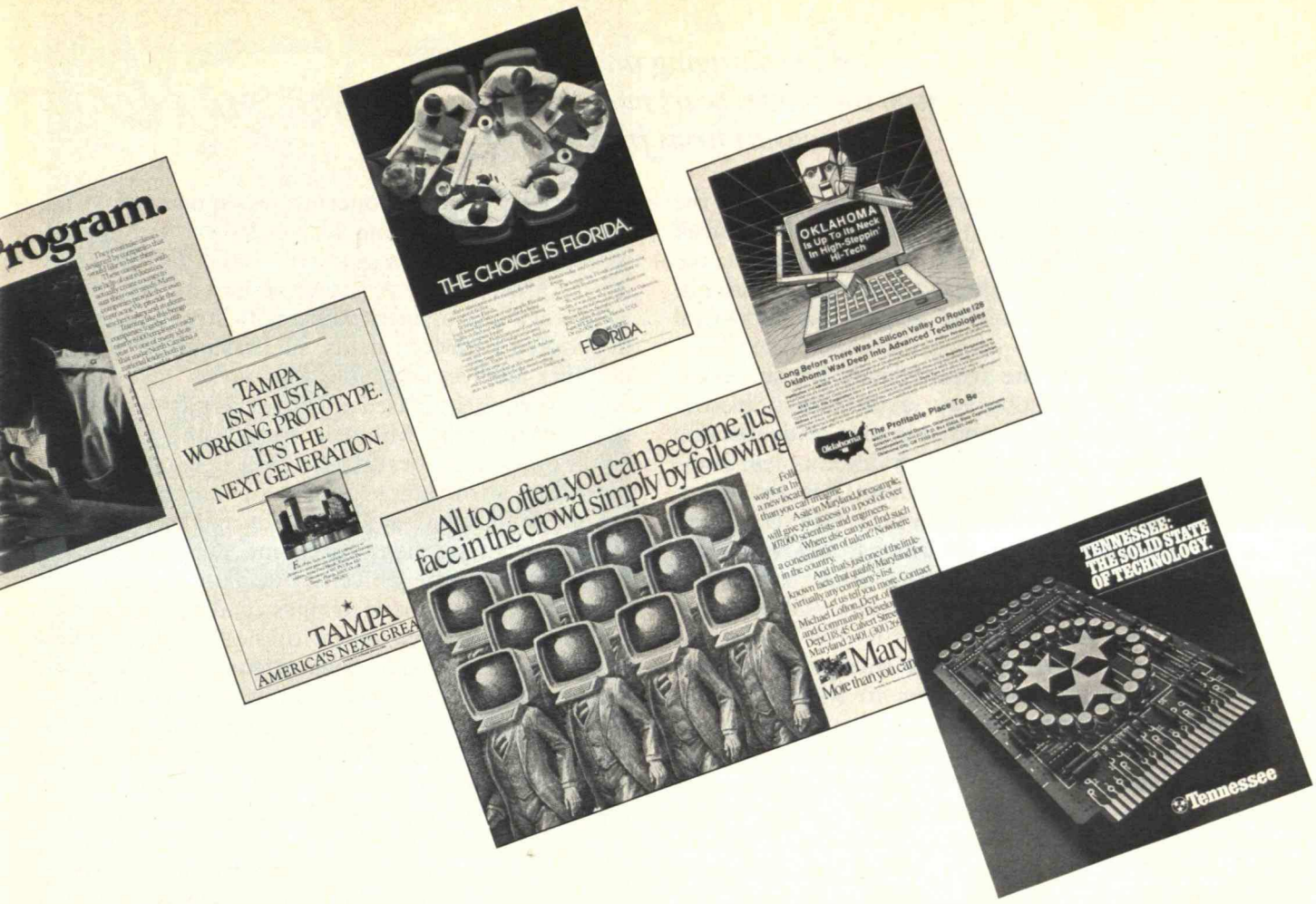
Refurbished industrial recruiting emphasizes high-tech traditions, skilled labor, and universities in addition to the usual lures of low taxes, low wages, and limited unionization.

Industrial Recruitment the Old Way

The most popular—and often least beneficial—high-tech development programs simply modify or extend existing strategies to strengthen local or state economies. As with traditional programs, the goal is to woo any and all investment and jobs.

Targeting high-tech industries is the most common modification. Industrial-recruitment advertising in specialized publications such as *High Technology* emphasizes an area's high-tech traditions, skilled labor, and universities in addition to the usual lures of low taxes, low wage levels, limited unionization, and other elements of a "good business climate."

A refurbished recruiting style accompanies the high-tech focus. Slick brochures that convey quality of life with photographs replace dry statistics that measure economic advantages. These appeals answer to the preference of professional and technical employees, expressed in survey after survey, for locations with a mix of amenities. For example, a poll by Fantus Corp. and *Industrial Research and Development* magazine found that climate, recreational opportunities, primary and secondary schools, and availability and cost of housing are most important



for attracting and holding research engineers.

Pennsylvania's Department of Commerce touts the state's open spaces with a photo of a fisherman in a swift-running stream: "Your business would be a better place to work if it were in a better place to live." Maine boasts of its small-town atmosphere, and Colorado calls itself "the ultimate fringe benefit." Oregon has been notably successful in winning firms who want the Pacific Coast quality of life without California's high costs. In addition to branches of Intel and National Semiconductor, Oregon has won over several Japanese firms, including Fujitsu, Kyocera, NEC, and the Epson subsidiary of Seiko. These Japanese companies desired Pacific Coast sites but also wished to avoid a California tax on multinational firms.

Many state policies are dominated by the industrial-recruitment traditions from which they have evolved. Colorado's Silicon Mountain corridor from Boulder to Colorado Springs, advertising its low costs, now has several Silicon Valley firms. The reason, says Bob Nordeman, who has directed the Colorado Springs Marketing Task Force, is that "the cost of doing business here is half—across the board—of what it is in Silicon Valley."

Designating "high-tech highways" or "silicon strips" is a cut-rate and popular way to add high tech to conventional industrial recruiting. By itself, it is of little use. Whether named by journalists (like Silicon Valley) or by local boosters (like Oregon's Sunset Corridor), these areas are intended to elicit images of the next Route 128. The names have proliferated along with the interest in high tech. Examples include Silicon Bayou around Lafayette, La.; Florida's Silicon Swamp; Silicon Gulch between Austin and San Antonio, Tex.; Bionic Valley in Salt Lake City, Utah; and the Tennessee Technology Corridor.

A catchy name will not attract high-tech industry. Many technology regions are only vaguely delineated; others are clearly optimistic about their resemblance to Silicon Valley or Route 128. For example, Oklahoma's High-Tech Triangle encompasses large areas of empty prairie.

To succeed, future technology centers must meet at least some of the criteria underlying those that are already established. Several elements characterize the leaders: a large urban region, abundant air transportation, and strong universities that provide ideas and technical workers. Perhaps equally important but even harder to replicate is a large and continual

Encouraging and nurturing new companies bears more fruit than trying to attract firms from elsewhere.

flow of government research funding, such as the Boston and San Francisco Bay areas have received since the Second World War. In both regions, the funding has augmented local advantages, and high-tech concentrations existed before this industrial genre had a name.

Fulfilling any of the requirements for success is impossible without one key factor that industrial recruiters and promoters often ignore: patience. The long-term character of high-tech development is especially striking in Scotland's Silicon Glen, the region from Glasgow to Edinburgh. In the 1940s, U.S. firms set up manufacturing plants in what is now labeled Silicon Glen to gain access to European markets and to take advantage of Scotland's sizable subsidies for industrial investment. Only in the 1970s did the more lucrative high-tech R&D enterprises become common. The U.S. counterpart to Silicon Glen is North Carolina's Research Triangle, which started in 1959 when the state-supported Research Triangle Park opened. The area did not begin to compete with other regions for major R&D facilities until the late 1970s.

Building the Base

Having accepted the need to adopt a long-term approach, states and communities can do much to attract out-of-state and foreign high-tech firms. One strategy is to improve the local infrastructure—utilities, roads, schools, and other public facilities. This strategy has the additional benefit of helping an area encourage and hold existing enterprises.

Boosting funding levels at state-supported universities enhances the high-tech image and attractiveness of a state. Unfortunately, university research is highly concentrated. Fifty universities account for over 60 percent of the total research funds. The state universities in Arkansas, Tennessee, and West Virginia don't even rank among the top 100 in the country.

Since creating and maintaining top-notch universities is neither easy nor cheap, some state programs focus on selected high-tech fields, typically those in which there is already some local strength. With a mixture of state support and commitments from local firms, Arizona and North Carolina have established large microelectronics research centers. New York, New Jersey, and Ohio also sponsor advanced technology centers devoted mainly to one field of technology. In Ohio, for example, the University of Cincinnati concentrates on manufacturing technology, Ohio State University on welding research, and Case Western Reserve and the University of Akron on polymers. In Massachusetts, state funds are spread among institutions with strong programs in selected high-tech fields, such as marine science, polymer science, and biotechnology.

Texas took a focused approach as part of the deal that brought the Microelectronics and Computer Technology Corporation (MCC), a semiconductor industry consortium, to Austin. In addition to agreeing to build MCC a $20 million facility, the state set up an endowment for science and engineering departments at the University of Texas at Austin of interest to the microelectronics center.

While universities appear on nearly all checklists of high-tech companies looking for a place to settle, their actual effect on a decision is less clear. Faculty research and a pool of graduates alone are not enough to spawn local firms. The successful regions have several top universities *plus* abundant venture capital and urban services. And research—especially the best research—can be procured from a distance, as industry-university agreements for biotechnology research have shown. Geography has not affected Du Pont support of Harvard Medical School and Caltech, Hoechst AG's agreement with Massachusetts General Hospital, or Exxon's arrangement with M.I.T.

On the other hand, long-term investment in higher education can pay off, as Texas demonstrated during the 1970s, when it rose into the top ranks of university research. This investment may be one reason why Texas now ranks among the leading states in the founding of new computer and software firms. Again, patience is crucial: the state's endowment of its universities dates from the 1920s. Less frequently noted is that oil revenue is almost the sole source of university funding. That revenue is fragile, booming with oil prices in the 1970s, and plummeting recently along with the oil market. To attract high-tech industry, university funding requires both a long-term commitment and a balanced source of support.

A second infrastructure improvement, access to other areas, is one of the most under-appreciated means of drawing in high-tech industry. Professional workers depend on face-to-face communication with people inside and outside their firm. Increasingly, this requires good air service. Raleigh-Durham, N.C., and Colorado Springs, Colo., have strengthened their appeal by acquiring additional air carriers

or becoming major airline hubs. To a large extent, the success of Silicon Swamp and Central Florida Research Park, with 14 tenants, is attributable to Orlando's plentiful air connections. Gainesville's University of Florida Research and Technology Park, a two-hour drive north, has limited air service and half as many tenants.

A third infrastructure attraction amenable to public policy is the quality of life. Many cities, such as Baltimore, Md.; Columbus, Ohio; and Pittsburgh, Pa., are attempting to brighten their images with downtown redevelopment, funding for local schools, and bond issues for parks and other civic improvements. Building up university research potential also contributes to the sense of an "intellectual atmosphere" that attracts high-tech enterprises. For many people, art and similar activities are standard components of cultural richness, and they, too, depend heavily on public support and enthusiasm. The Research Triangle; Ithaca, N.Y.; Athens, Ga.; and State College, Pa., compare culturally to much larger cities because of facilities available on campuses. These examples show that other places, if they can attain some of the attributes of metropolitan areas, can get at least a small slice of the high-tech pie.

The kicker is that a desirable quality of life has a price: higher taxes. And successful high-tech areas must continually maintain and upgrade their services to keep their quality of life competitive with that of other regions.

Building New Firms

Encouraging and nurturing new companies bears more fruit than trying to lure firms from elsewhere. As a result, some state-level financial incentives are based on the fact that high tech evolves and grows in large part because of continual entrepreneurship. The hope is that rapidly growing local high-tech firms might replace declining industries.

To nurture enterprises that might be unable to secure private finances, at least 20 states have created public venture-capital funds. Such policies attempt to imitate the model of private venture capitalists who provide money for risky start-ups in return for part ownership. The investors—whether private or public—hope to reap a high profit by picking the winning young firms in dynamic industries. This speculative investment may be lost entirely if the firms fail, which is what distinguishes venture capital from arrangements such as small-business loans that expect a full and predictable payback. Extending the principle, some states and communities offer seed financing—small investments to get the riskiest projects going and encourage larger private venture-capital involvement.

Connecticut, Indiana, Massachusetts, Michigan, New York, Ohio, and Pennsylvania are the major players. Most stretch the public investment with matching funds from private sources. Pennsylvania offers one dollar of state money to match three dollars in private money. The New York State Science and Technology Foundation's Corporation for Innovation Development has invested $3.2 million in young firms, leveraging an additional $15.1 million from the private sector and other public sources.

Even local communities are getting into the seed-and-venture act. North Greenbush, N.Y., near Rensselaer Polytechnic Institute (RPI), has raised over $1 million in grants from the Department of Housing and Urban Development. It invests up to $100,000 in small companies, some of which have been start-ups at RPI's high-tech park that were unable to find private capital.

One problem with public venture-capital funds is that they have difficulty matching the personal relationships that are the heart of the private venture-capital industry. Contacts between individuals inform investors about opportunities much more than do applications "off the street." With the proliferation of venture funds, expert managers are hard to

Communities can profit from industrial recruiting even if it fails to create new high-tech regions.

find. Moreover, the networks are decidedly local. According to William Barnum, of the Los Angeles venture-capital firm of Brentwood Associates, "There's definitely a bias toward companies that are close to home. I wouldn't say that we'd never do a deal more than 50 miles away, but you won't get a guy to fly to Biloxi, Miss., from Los Angeles every week."

The private venture-capital industry is also highly concentrated geographically. California received 44 percent of the $2.6 billion in venture capital invested by private firms in 1985. Another 13 percent went to Massachusetts.

It is too soon to tell whether public venture capital or seed money can substitute for a lack of private funds. Most state funds are too new to have any track record, especially since return on investment is slow. Only Connecticut and Massachusetts began such programs before 1980, and most have started investing since 1985. New York has received only $420,000 in dividends and repayments on its $3.2 million invested through March 1987.

Moreover, although some funds have been established to counter the geographical concentration of private money, a number of the biggest are in states like New York and Connecticut that have the best access to such resources. Venture capital is still scarce in North Carolina's Research Triangle; consequently, very few new companies have taken root despite the area's attraction for the headquarters and R&D operations of large firms.

The Science Park Route

Another popular way to encourage young companies is to cater to the preference of R&D firms for a campus-like setting. Called science parks, research parks, and technology parks, these specialized industrial developments reflect the clean office image of high-tech activities.

Business Facilities magazine recently listed 104 university-affiliated research parks in 37 states. Florida led the parade with 9 parks, followed by Pennsylvania with 7, and Illinois and New York with 6 each. Occupancy rates tend to be highest in places where high tech has caught on for other reasons. Some of the more successful parks, each with over 50 tenants, are the Princeton Forrestal Center, Philadelphia's University Science Center, and New Haven Science Park. Each is near a major urban region and is affiliated with a world-class research university.

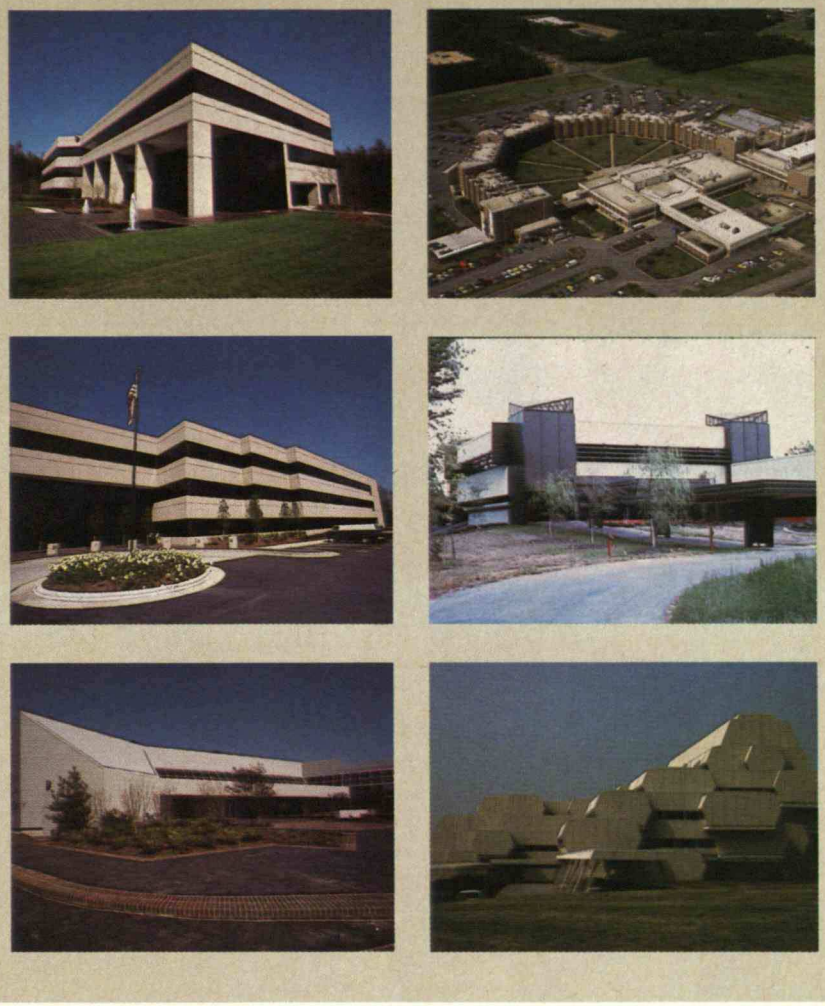
Metropolitan areas with their amenities and infrastructure remain the prime sites for new firms. It is not surprising, then, that so few science parks in the United States have thrived, or that the most successful tend to be in large urban centers. Those in out-of-the-way towns like Fayetteville, Ark., and Pullman, Wash., have few, if any, tenants.

A more promising tactic is to create incubator facilities that "nurture" firms and allow them to "grow up" and find permanent local homes. Many incubators—called innovation centers when they serve exclusively high-tech companies—feature shared tenant services that can significantly reduce the need for start-up capital. David Allen of Pennsylvania State University has examined 12 incubator facilities in Pennsylvania and found that at least half provide in-house assistance on government regulations, government procurement processes, business strategy preparation, and plans to relocate. Tenants in New Haven Science Park share a common word-processing service, receptionist, copy center, and personal-computer rental.

Rather than charging rent for incubator space, a landlord (often a major university) may take some equity in its tenant companies. The Utah Innovation Center takes the highest cut—30 percent of equity. At the low end of the scale, tenants in Rensselaer Polytech's incubator in Troy, N.Y., pay low rent while giving up 2 percent of their equity.

Incubators are a welcome policy shift away from wooing distant firms and toward supporting local entrepreneurs. Moreover, they are prominent in the comprehensive approach that a few states have undertaken. Pennsylvania's Ben Franklin Partnership combines incubators and venture capital with existing strong bases of university research and industry R&D.

Because the Ben Franklin Partnership addresses several elements of high-tech economic development at once, it has attracted significant private-sector support. The first $28 million in state funds for joint industry-university R&D projects in 1984 and 1985 was matched by $84 million from industry and foundation sources. The visibility and potential of the Franklin Partnership's four advanced technology centers has also made venture capital more available. At least two new seed-capital funds began in 1986—one in Pittsburgh, the other in State College.



North Carolina's Research Triangle Park developed over 25 years. It now has about 50 tenants, including (clockwise from top left) Glaxo, the Environmental Protection Agency, IBM, Becton Dickinson, the Microelectronics Center of North Carolina, and Burroughs Wellcome.

The Limits and Potential of Public Policy

In trying to foster economic growth through high technology, states and communities must focus on what they can control. While public policy can't create entrepreneurs, public venture-capital pools *can* encourage local entrepreneurs to remain in the area rather than seek better investment opportunities elsewhere. Public policies can also bring entrepreneurs together through incubator facilities and integrate universities into civic and economic life. But since entrepreneurship is very much a local phenomenon, states must capitalize on and build up existing local strengths.

In addition, public policy must recognize its limited power to speed up the high-tech development process. Silicon Valley and Route 128 started at least 20 years before they were recognizable as high-tech regions. Others, such as Silicon Glen, have only recently begun to develop entrepreneurial activity. But the 25-year evolution of North Carolina's deliberate efforts to promote the Research Triangle shows that high-tech policies can bear fruit if they are focused on a small region with potential for economic development.

Moreover, while the employment gains from high technology may not be large or necessarily permanent, a well-designed state or local development policy can do much to strengthen a high-tech base. And such strategies have already contributed beneficial policy spin-offs. They have prompted a longer-term perspective about economic development and more patience to wait for small firms to grow and science parks to fill. They have demonstrated the connections between universities and the economy, and they have shown the significant advantages to be gained from investments in human capital, especially through education.

Thus, communities can profit even if industrial recruiting fails to create new high-tech regions. Everyone wins when towns deemphasize the traditional lures of low taxes, low wages, and limited unionization and instead improve their airport facilities, schools, research infrastructure, local entrepreneurship, quality of life, and training for technical workers.

Even if undertaken only partially and half-heartedly, high-tech incentives can produce benefits. It remains to be seen whether farsighted policies will win out over those aimed at short-term gains. □

PHOTOS: RESEARCH TRIANGLE FOUNDATION OF NORTH CAROLINA

Power Lines and Cancer: The Evidence Grows

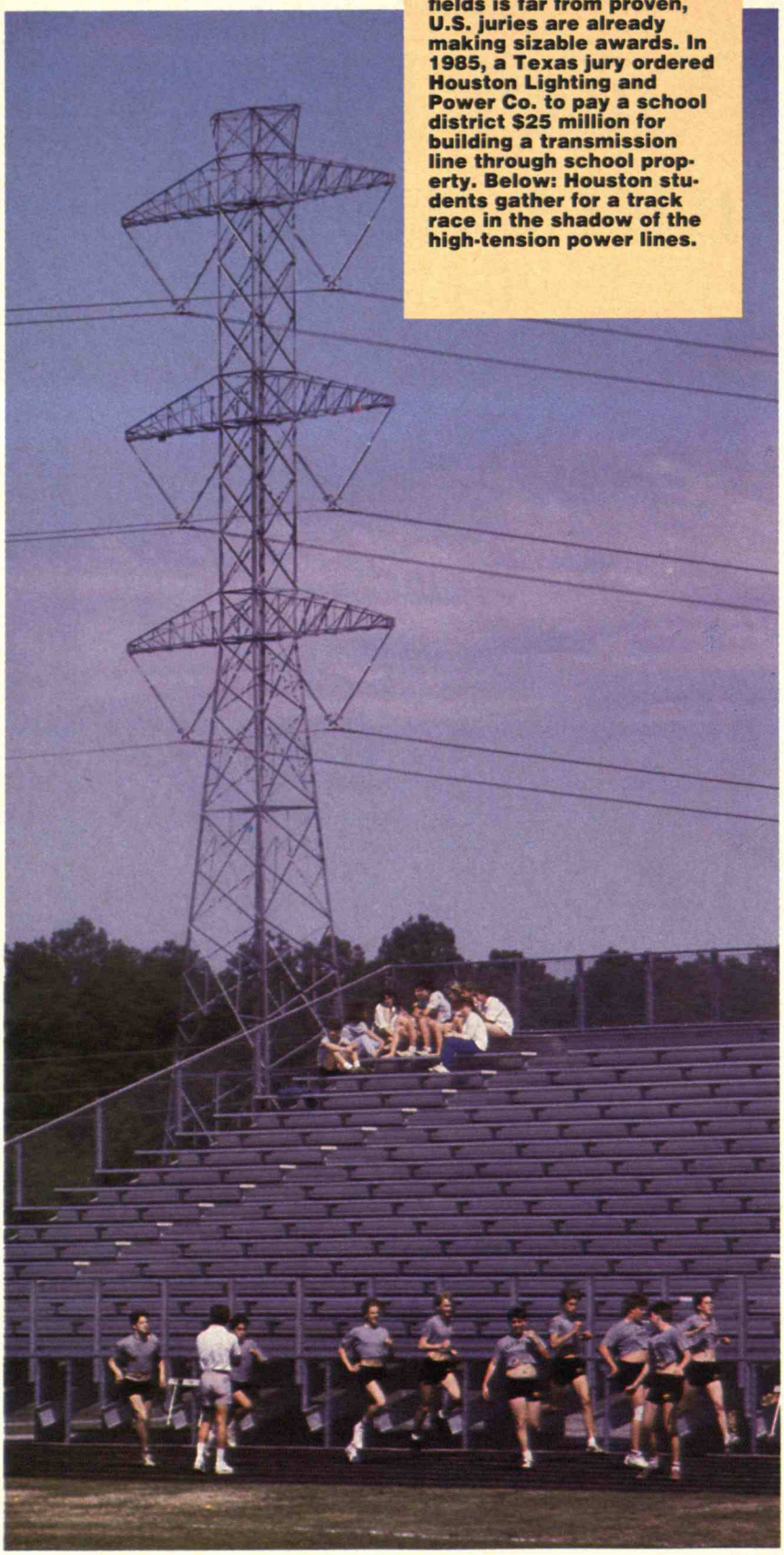
At a time when studies suggest a link between cancer and exposure to the magnetic fields generated by electrical power lines, government research funds are drying up.

UTILITY companies long ago realized that building power plants, whether coal or nuclear, could be the cause of major headaches. Those headaches are becoming migraines as more and more studies suggest a link between cancer and the extremely low frequency (ELF) fields emitted by electrical power lines. For each power plant, utility planners have to grapple with the "not in my backyard" syndrome. But when it comes to power lines, they face an endless series of backyards. In the United States alone, there are 600,000 miles of overhead transmission lines in place and thousands more under construction or being planned.

The risk of developing cancer from exposure to power line fields is still far from proven. While some studies suggest an association between living or working near power lines and a higher incidence of cancer, others show no such association. U.S. juries, however, are already making sizable awards based on the available data. In late 1985, for instance, a Texas jury ordered Houston Lighting and Power Co. to pay a local school district $25 million in punitive damages after the utility built a transmission line through school property without permission. The

BY LOUIS SLESIN

ILLUSTRATION: JOAN HENDERSON/VISUAL CONSPIRACY



Even though the cancer threat from power line fields is far from proven, U.S. juries are already making sizable awards. In 1985, a Texas jury ordered Houston Lighting and Power Co. to pay a school district $25 million for building a transmission line through school property. Below: Houston students gather for a track race in the shadow of the high-tension power lines.

jury's award was based almost entirely on the potential cancer threat, according to H. Dixon Montague, the plaintiff's attorney. In Florida, juries have awarded more than $1 million to owners of land next to high-voltage power lines. Here again, expert testimony on the cancer link has been pivotal. Without doubt, juries are the wrong forums in which to settle complex scientific controversies. But they can indicate the relative credibility of each side's expert witnesses.

All of these cases are under appeal. Nevertheless, such large sums of money are strong incentives to other plaintiffs, and to lawyers looking for ways to make a name for themselves. That fact, coupled with the sheer pervasiveness of power line fields, explains why a senior executive with the Electric Power Research Institute (EPRI), a utility-supported group, recently called the ELF-cancer link a "jugular issue" for the industry.

A Priceless Natural Resource

Electromagnetic fields (EMFs) and radiation are the cornerstones of the electronic age. The non-ionizing electromagnetic spectrum ranges from the ELF fields associated with power lines—60 cycles per second, or hertz (Hz), in North America and 50 Hz in Europe—to visible radiation from the sun at 500 trillion Hz. The electromagnetic spectrum is a priceless natural resource; its applications are without limit and, like all resources, competition for its use is fierce.

Radio and television stations broadcast between 530 kilohertz (kHz:1 kHz equals 1 thousand Hz) and 806 megahertz (MHz:1 MHz equals 1 million Hz). Microwave ovens operate at 2.45 gigahertz (GHz:1 GHz equals 1 billion Hz), a frequency similar to those used for satellite communications and telephone links. Radars and electronic warfare systems use a host of different types of radiation in the MHz and GHz bands. Hyperthermia heat treatments for can-

PHOTO: RICHARD J. CARSON

Power station operators were found to have 2.5 times the death rate from leukemia.

cerous tumors operate in frequencies from 50 MHz to 1 GHz, and the nuclear magnetic resonance imager, a powerful tool for diagnosing certain diseases, uses various types of MHz radio signals. Meanwhile, electric power lines share the ELF frequencies with some exotic communication systems. The U.S. Navy's Project ELF, designed for sending messages to submerged submarines, operates at 76 Hz.

Unlike nuclear and X-ray radiation, EMFs are not powerful enough to break molecular bonds or create charged particles, called ions. As a result, many observers have concluded that as long as EMFs do not cause shock or heating of body tissue, there is nothing to worry about. Over the years, however, more and more studies have suggested that non-ionizing radiation can produce non-thermal effects.

Power line EMFs were first linked to cancer by Nancy Wertheimer and Ed Leeper in 1979. They combed childhood mortality records in the greater Denver, Colo., area and correlated the incidence of cancer with the network of high-current power lines. This landmark epidemiological study showed an association between long-term exposure to weak (60 Hz) magnetic fields and increases in the incidence of cancer. At the time, the findings seemed preposterous. After all, the magnetic fields in question were a hundred times smaller than that of the earth. There is one crucial difference, however. The earth's magnetic field is relatively steady, while power line fields are constantly oscillating.

The cancer issue resurfaced in 1982—this time in the workplace. "In the course of updating a study of occupational mortality, I noticed that among men whose occupation required them to work in electrical and magnetic fields there were more deaths due to leukemia than would be expected," Samuel Milham told readers of the *New England Journal of Medicine*. For instance, compared with other people not exposed to EMFs, power station operators had two-and-a-half times the death rate from all types of leukemia.

By publishing his work in one of the world's leading medical journals, Milham, a well-known occupational health physician at the Washington State Department of Social and Health Services, prompted renewed interest in EMF interactions. A bustle of activity followed as researchers checked whether Milham's findings for Washington State workers held true for other sets of cancer data. Letters to the editor soon appeared in the medical literature, and most supported what Milham had called a "suspicious association."

By early 1986 even skeptics were becoming troubled by the weight of evidence. Out of 17 occupational surveys of electrical and electronic workers, 15 showed some link between ELF fields and cancer. That February, at a meeting of power engineers, Tom Tenforde, a researcher in the Biology and Medicine Division of the Lawrence Berkeley Laboratory in California, warned that "something is going on," and that there is a "real need" for further studies, given the "apparent correlation between cancer and EMFs." Yet few in the utility business seemed to care. Only a couple dozen of the more than 2,000 attending the meeting bothered to come to the specially organized symposium on the biological effects of power lines.

Meanwhile, new evidence supported the Wertheimer/Leeper contention that the general public—those not exposed at work—might also be at risk. Dr. Lennart Tomenius, a Swedish researcher, working in his spare time, without funding, had painstakingly repeated and found support for the original 1979 findings. In a study published in *Bioelectromagnetics,* he confirmed that the distribution of childhood cancer in Stockholm was linked to power line magnetic fields. Meanwhile, Wertheimer and Leeper had extended their findings to adults: though the association between cancer and EMFs was weaker than the one they had observed in children, it was still statistically significant.

A Mini-Explosion of Activity

Many scientists, however, were not convinced. They wanted more substantial evidence of a cancer risk. Yet large epidemiological studies are notoriously expensive and time-consuming. Without major funding, no one could try to repeat the Wertheimer/Leeper study for the general public or initiate a full-scale occupational study. Money was scarce, and the Reagan administration had no interest in opening up a new front of environmental activity. The field might have stayed quiescent had it not been for a 10-year-old power line dispute in New York State.

In 1973 the New York Power Authority an-

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Phillips sent a chill through the crowd when he said he would not buy a house along a right-of-way.

nounced plans to build a 765-kilovolt (kv) transmission line to import cheap hydroelectricity from Canada. Environmental groups fought the line, citing studies that even then pointed to health risks. The state's Public Service Commission (PSC) okayed the line, but, after acknowledging that the hearing record contained "unrefuted inferences of possible risks that we cannot responsibly ignore," ordered the utilities to chip in $5 million for a five-year research project on the health effects of EMFs. In 1981, the New York Department of Health began soliciting proposals.

One of the experiments the PSC found especially persuasive showed that the offspring of mice constantly exposed to power line fields were born stunted. In 1976, Dr. Robert Becker and Andrew Marino, then working at the Veterans Administration Hospital in Syracuse, N.Y., reported that the effect became worse with succeeding generations. Their study, done on a shoestring budget, was corroborated by Richard Phillips and Larry Anderson in a well-funded experiment sponsored by EPRI.

The New York Power Line Project initiated a mini-explosion of activity that permanently transformed research on the biological effects of EMFs. The money not only paid for new studies but also brought fresh ideas into an otherwise stagnating field.

Most important, the New York project paid for a repetition of the Wertheimer/Leeper epidemiological research—an initiative that neither the federal Department of Energy nor EPRI had been willing to support. David Savitz, a young epidemiologist then at the University of Colorado, teamed up with two colleagues in the school's Department of Electrical Engineering and embarked on a $350,000 study. They made extensive measurements of the local power line magnetic fields in the homes of children who had developed cancer as well as those of healthy children. But even after they took every precaution they could think of to ensure that their results would be sound, there were still insoluble problems: the researchers would never know the precise magnetic fields the children had been exposed to years earlier. Any conclusions from the Savitz group could therefore always be disputed.

By the fall of 1986, results were overdue. Rumors began to circulate that Savitz would support the Wertheimer/Leeper cancer link. In September utility managers assembled in Toronto for the first international symposium on the health effects of power line fields. The attendance itself told much of the story: it was double the expected number. Savitz was there but still not ready to disclose his findings.

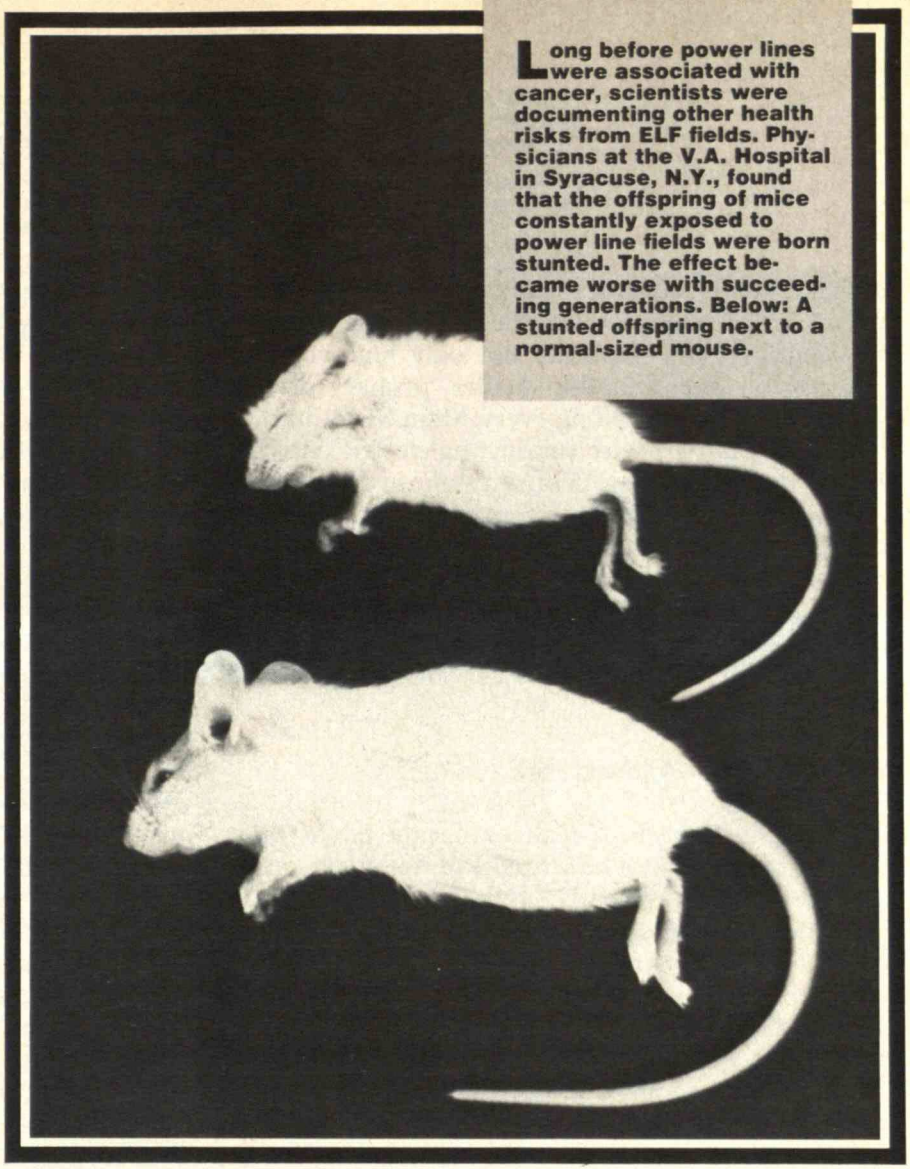
The meeting might have simply been a tutorial for the uninitiated had it not been for the disaffection of one of the leading EMF researchers, Richard Phillips. After years of doing ELF research at the Battelle Pacific Northwest Labs, a private consulting firm in Washington State, Phillips had joined the Environmental Protection Agency (EPA) in 1984.

No one regards Phillips as a Cassandra. The editor-in-chief of the Bioelectromagnetics Society's journal, Phillips is well known and trusted in the utility industry. In fact, many of his studies at Battelle were funded by the utilities through EPRI. So when Phillips told a jammed audience at the Toronto conference that he would not buy a house along a power line right-of-way—not even with a $25,000 discount to mitigate any perceived risks—he sent a chill through the crowd. He said that prospective home owners often consulted him on such matters, and that his usual response was, "If it bothers you, don't buy it." For years utility companies had sloughed off such queries. The Edison Electric Institute, a trade association based in Washington, D.C., attempted to allay any public anxiety about living near power lines by telling readers of its brochure, "The electric utility industry is confident that the voltage levels currently in operation pose no risks to humans or animals."

At another conference two months later, Savitz finally announced that "prolonged exposure to low-level magnetic fields may increase the risk of developing cancer in children." This July when the New York project released its final report, it endorsed Savitz's conclusion but maintained that the cancer link was still a hypothesis, albeit now a "stronger one." The cancer story made headlines all over the world.

How ELF Fields Affect the Body

If ELF power line fields can promote cancer, they are obviously capable of affecting human biochemistry. Even though some experts still regard both propositions as heretic, no one should find them surprising. Fish and birds can detect and interpret minuscule fields for orientation and navigation. Most significantly, the human eye can detect extraordinarily



Long before power lines were associated with cancer, scientists were documenting other health risks from ELF fields. Physicians at the V.A. Hospital in Syracuse, N.Y., found that the offspring of mice constantly exposed to power line fields were born stunted. The effect became worse with succeeding generations. Below: A stunted offspring next to a normal-sized mouse.

weak high-frequency fields.

The greatest pressure to admit the existence of non-thermal EMF effects has come from those who believe that electromagnetic fields can mend broken bones, neutralize chronic pain, and even regenerate nerve cells. Indeed, Becker and Marino, who played a central role in the New York power line dispute, were initially interested in the potential biomedical applications of ELF fields. Becker's laboratory started working on EMF effects in the late 1950s, and one of his earliest efforts was to find out how salamanders harness internal electromagnetic forces to regenerate limbs.

Other scientists have been trying to understand just how ELF fields affect basic molecular processes in animal and human cells. In the 1970s, Dr. W. Ross Adey and Suzanne Bawin, now at the Veterans Hospital in Loma Linda, Calif., discovered that 16 Hz fields, as well as microwave radiation modulated at 16 Hz, could alter the behavior of calcium ions in brain tissue. Calcium plays a key role in a large number of cellular reactions.

The calcium work has been repeated and extended in a number of labs—notably by Carl Blackman of the EPA. He has found that fields of 50 Hz and 60 Hz can activate the movement of calcium within cells. Also, Adey and Blackman have discovered that other changes occur in cells exposed to ELF fields. Such exposure, for instance, can alter the surface of cell membranes.

The research by Adey and Blackman clearly shows that ELF interactions are very subtle: changes occur only at certain "windows" of frequencies and power levels. For example, as the frequency of the field increases above 16 Hz, the calcium flow subsides, only to bounce back at 45 Hz. Small changes in the strength of the field can induce a similar disappearing-reappearing act.

More recently, Adey has pieced together a three-stage theory to explain how weak ELF fields (at 60 Hz) might promote cancer. The field hits the cell, sparking a chemical change on its surface, and the altered chemical signal is transmitted into the cell interior. Once there, it triggers a sequence of chemical reactions that distorts the normal flow of biochemical information in the cell and between cells. A key step is the amplification of the weak field on the membrane surface.

The result is a cell whose growth is out of control. Adey's theory is controversial, and more experimental work is needed to provide confirmation. However, other research supports the idea that EMFs can affect cell regulation. Abraham Liboff, a professor at Oakland University in Rochester, Mich., has shown that a wide range of magnetic fields can enhance DNA production in cell cultures. According to research by Reba Goodman of Columbia University, EMFs can induce RNA to generate proteins that would otherwise not be found in cells. And Jerry Phillips of the Cancer Therapy and Research Foundation in San Antonio, Tex., has discovered that human tumor cells, when exposed to power line fields, proliferate more easily and are more immune to attack.

PHOTO: ANDREW A. MARINO

At stake is the entire network by which utilities move electricity into customers' homes.

Such findings are hard to believe because the fields at issue are so small. Indeed, the Wertheimer/Leeper and Savitz studies implicate not only high-voltage transmission lines but the smaller, primary distribution lines that run along every Main Street in the United States. (Any wire conducting electric current will generate a magnetic field.) At stake in this debate is the entire network by which utilities move electricity from generating stations into customers' homes. (Some utilities are switching to direct current, or DC, power lines, which avoids the cancer issue but may raise other environmental concerns. DC lines, however, remain a tiny fraction of the existing network.)

Holes in the ELF-Cancer Link

The utility industry now realizes that the power line cancer dispute will not be settled without much more research. EPRI has recently expanded its EMF effects program and hired new staff. Leonard Sagan, EPRI's recently appointed manager for radiation studies, wants to expand even further. "The utilities are taking this matter very seriously," he says, "though there is still a lot of skepticism."

Some epidemiologists and utility experts who have had the chance to read Savitz's report for the New York project also remain unconvinced. Florida is drafting power line exposure standards, and Dr. Philip Cole, chairman of the Department of Epidemiology at the University of Alabama, Birmingham, has informed the state that the Savitz study is only "suggestive of a weak effect," and that the data are inconsistent. Moreover, Cole says the research shows no "dose-response relationship"—that is, it provides no direct proof of a relationship between ELF exposure and cancer. Indeed, Cole characterizes the entire ELF literature as showing that "either there is no relationship between EMFs and cancer in human beings or if there is an effect it must be of very low magnitude even among people who are moderately to heavily exposed."

Others, like Dr. Sol Sax, chief physician at Ontario Hydro, argue that the Savitz data are "ambiguous," because the study found a weaker association between cancer and *measured* ELF fields within homes than between cancer and the index used to *predict* exposure. The index, first developed by Wertheimer and Leeper, estimates the long-term exposure that children would have had to ELF fields, given the type of power lines near their homes. If a 60-Hz power line is 240 kv, for instance, the index predicts that the exposure would be higher than it would be in a house at the end of the electrical distribution network.

Wertheimer, Leeper, and Savitz, among many others, argue that the index is a far better indicator of long-term exposures than a few instantaneous readings. Field surveys suggest large variations in ambient ELF fields, and the index provides a way of addressing this variability.

With or without the index, much more work needs to be done to address people's exposure to EMFs. Sax would like to see additional health surveys of individuals and workers with higher exposures than those in the Savitz study. On this point, he agrees with Wertheimer and Leeper, who have been pressing for studies on users of electric blankets. (The zigzagging wires in the blankets carry electric current that generates both heat and ELF magnetic fields.) Wertheimer and Leeper have already shown that pregnancies among couples who use electric blankets are more likely to end in miscarriages than those among couples who do not heat their beds electrically. However, a possible cancer connection has yet to be investigated.

The Funding Dilemma

Risk assessment will not be easy. Regulators used to setting standards for nuclear radiation and toxic chemicals on the basis of direct dose-response relationships will scratch their heads when confronted by EMF effects that can come and go as the field becomes stronger. Mechanisms of cause and effect will have to be verified and thresholds discerned. Yet at the precise time when new studies are showing increasing cause for concern, government research funds have dried up.

The Reagan administration has consistently slashed budgets within the various federal agencies for research on the health effects of non-ionizing radiation. Sometimes those budgets are reinstated by Congress; other times they're not. For instance, Phillips's bioelectromagnetics lab at EPA hung on through budget cycles from fiscal 1983 to fiscal 1986, fighting each year to remain open. In 1980, there were 26 scientists working in that area, but by the end of 1986 there were none. EPA officials in Washington had finally succeeded in forcing Phillips

The extremely low frequency (ELF) fields generated by power lines can modify cells' biochemistry. Below is an artist's rendering of one theory of how these fields could promote cancer. The field hits a cell's surface (a), causing chemical change, and a "forest" of highly charged proteins (b) amplifies the altered signal. The signal is transmitted through the cell membrane (c), where it affects powerful chemical reactions. For instance, it can affect two important enzymes: adenylate cyclase (d), which controls the cell's metabolism, and ornithine decarboxylase (e), which is essential for DNA synthesis.

to completely disband his research group. A similar game has occurred at the Department of Energy. Its fiscal 1986 budget for EMF research was cut in half from the fiscal 1985 level.

The New York State Power Line Project has folded, stranding most of those who had been attracted to the field. The funding paradox has not been lost on Savitz, who is now at the University of North Carolina in Chapel Hill. "The credibility keeps growing, but the money keeps shrinking," he notes.

The U.S. Congress could take a cue from Sweden. There, health officials have already embarked on a large-scale epidemiological study of all those with certain types of cancer who lived within 300 meters of a 220- or 400-kv power line for at least one year between 1960 and 1983. This and related ELF research will cost the Swedish government $1 million. Sweden, a relatively small country, continues to lead the world in its commitment to the environment and occupational health.

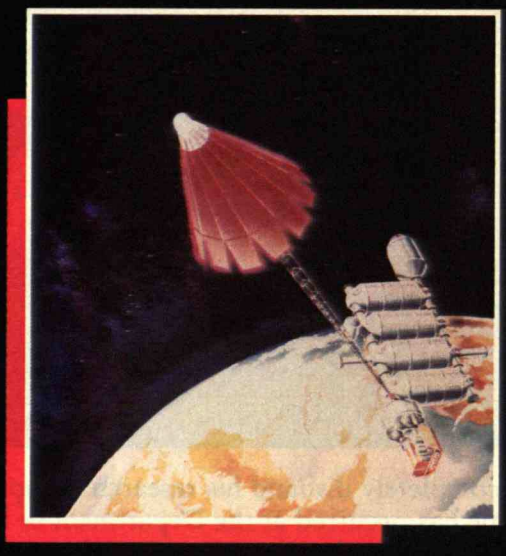
The Savitz study has prompted Congress to hold hearings, but the funding burden will probably fall elsewhere—perhaps again on New York State. Early this year, a group of more than 55 landowners filed a $60 million suit against the New York Power Authority, alleging that a power line—a half-completed extension of the originally disputed line from Canada—could create a "cancerphobia corridor," destroying the market value of their property.

Some observers claim that these landowners are primarily concerned about the aesthetic damage resulting from the construction of large power lines. But regardless of their motivations, their attorneys will take the cases to court. Because the industry and the government have refused to fund the necessary studies, policies for siting power lines will remain in the hands of local juries across the country, and there is now plenty of credible data supporting those who allege a cancer risk. □

ILLUSTRATION: FRANK ARMITAGE

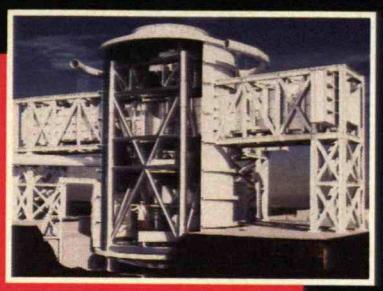
The Confused Course of SDI

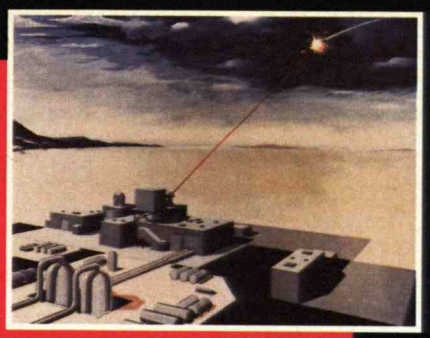
BY PETER CLAUSEN AND MICHAEL BROWER

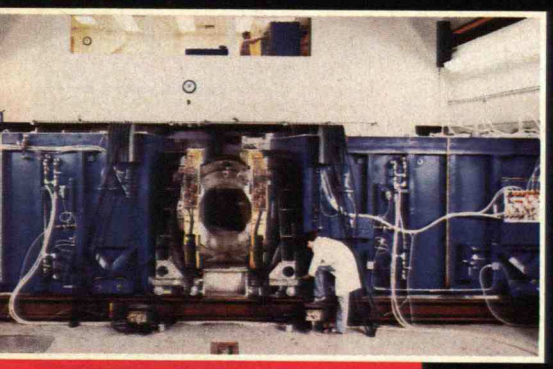


In four years the Strategic Defense Initiative (SDI)—the Reagan administration's program to develop a shield against nuclear attack—has grown from a distant presidential vision into the single largest item in the U.S. military budget. Nominally still a research program, it has become a virtual strategic and moral imperative for the administration, as well as the biggest issue in the Geneva arms talks. Yet SDI's future is up for grabs. As the 1988 elections approach, the struggle to shape this key part of the Reagan legacy has begun in earnest.

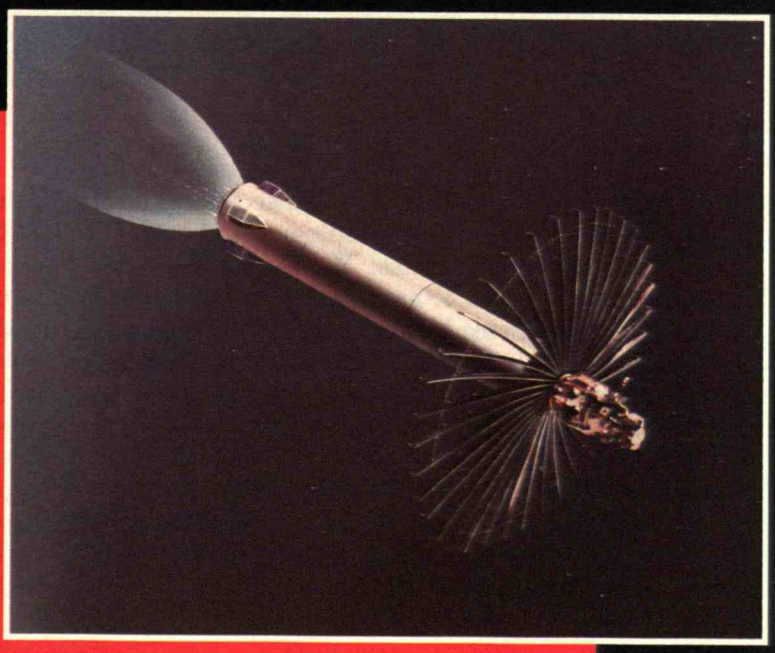
SDI's most ardent supporters, led by conservatives such as Republican presidential candidate Jack Kemp, favor deploying an actual defense system as early as the 1990s. Defense Secretary Caspar Weinberger would also accelerate the program and cautions against any compromise on SDI at the arms talks. SDI's critics, including the Democratic candidates, generally support research. But they would pursue arms control with the Soviet Union and postpone the

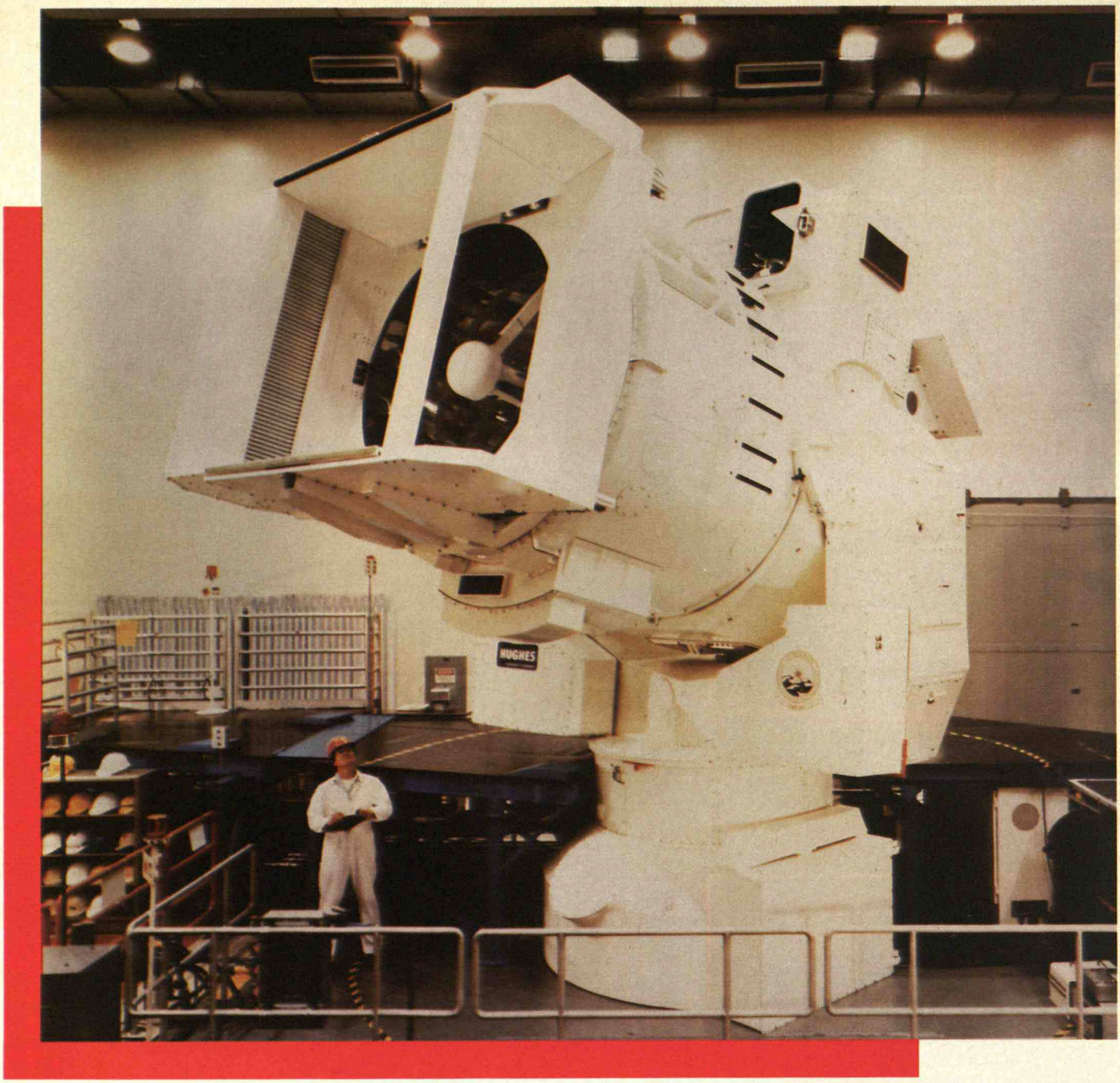






Under pressure to achieve results, SDI has shifted from one large project to another but has found no effective missile defense. The program should go back to basic research.





question of deploying a missile-defense system until more is known about the technologies and costs.

We are among the critics. We believe that, although salvageable, U.S. missile-defense research is in sad disarray. Instead of making steady progress toward clear goals, the SDI Organization (SDIO), which oversees the program, has charted a zigzag course under pressure to show results.

Until last year, the SDIO placed the highest priority on large experiments to develop directed-energy weapons such as lasers and particle beams—the classic Star Wars technologies. This year an authoritative report of the American Physical Society (APS) relegated directed-energy weapons to the distant future at best. SDI officials view the report as too pessimistic but have actually acted in accord with many of its conclusions. Even before it came out, the SDIO had shifted its emphasis from directed-energy weapons into a more prosaic type that the APS report did not consider—"kinetic-energy" weapons. These ground- and space-based rockets would home in on Soviet missiles and destroy them by direct impact. Some missile-defense advocates believe a system based on this technology could be deployed by the early 1990s. Critics including ourselves believe it would be ineffective against any serious Soviet at-

At first, SDI researchers envisioned using space-based chemical lasers to destroy Soviet missiles before they could release multiple warheads. However, the lasers could not be made powerful enough. Also, aiming them would require even larger, more expensive mirrors than the one in this beam director, which was designed for a laser with less than a tenth the power of an actual weapon. Scientists turned to other lasers, but when these appeared to offer long-term prospects at best, more prosaic interceptor rockets became the leading SDI weapons.

tack. Although directed-energy weapons are still under study, the prospects for kinetic-energy weapons now dominate the technical debate.

The political motive behind early deployment is the desire to give SDI an irreversible momentum so that it cannot be "tampered with" by a future administration, as Attorney General Edwin Meese has put it. Advocates fear that without a decision to put up a defense system—President Kennedy's pledge to land a man on the moon is invoked as a model—SDI will wither away once its patron leaves. They even worry that President Reagan might be tempted to bargain away the program for an arms-reduction accord. That possibility was underscored at last fall's Reykjavik summit, when the president tentatively agreed to confine SDI within the provisions of the 1972 Anti-Ballistic Missile (ABM) Treaty, which restricts missile defenses, for ten years. Though the deal fell apart, the specter of a "grand compromise" linking limits on defenses to reductions in offensive weapons continues to haunt SDI advocates.

In the maneuvering over SDI's future, even the meaning of the ABM treaty has become controversial. Under a new interpretation announced by the administration in 1985, the treaty would constrain only 1972-era missile defenses, not the "exotic" technologies of SDI. All but one of those who negotiated the treaty—the exception is Paul Nitze, now the President's chief arms-control adviser—reject the new version, and even the administration has not officially put it into practice. But the SDIO claims it could save time and money by performing "realistic" tests if the more permissive policy is adopted. Early-deployment enthusiasts would welcome such a move as a way to burn SDI's bridges behind it.

In the coming year, the United States will make critical decisions on SDI's budget, research strategy, and testing plans. To decide wisely the government must have a clear idea of where SDI stands as a research program and, just as important, where it should be headed. Why do we need missile-defense research, and is SDI the right program to meet that need?

The Evolution of SDI

SDI's brief history displays several features that would be unusual if this were truly an exploratory research program: very rapid budget growth, from about $1 billion in 1984 to $3.5 billion in 1987; a heavy concentration on a few large-scale experiments; and sharp fluctuations in focus.

SDI's twists and turns are most evident on boost-phase defense weapons. These weapons would supply the critical first line of defense, operating from space to attack Soviet missiles within minutes after launch, before they could release multiple warheads and decoys. The approach favored for this role has repeatedly changed, with hundreds of millions of dollars in proposed spending reallocated each time.

Until last year, the SDIO's plans for boost-phase defense centered on a succession of possible directed-energy weapons. Such weapons would have the advantage of being able to strike almost instantaneously across great distances. The SDIO initially focused on orbiting chemical lasers, which would derive power from heat-producing chemical reactions. These are technically more mature than other lasers, but researchers encountered a number of problems. Accurately aiming the comparatively long-wave infrared light from chemical lasers requires large, expensive mirrors. Tons of chemical fuel would have to be placed in orbit, at great cost, to power each laser. And researchers concluded that no individual chemical laser could produce enough power. Several lasers would have to be combined in phase—with their wave fronts marching in step—to produce the 20 or more megawatts (million watts) of power required. The technology to accomplish this is in its infancy. While SDI continues to test a 2-megawatt hydrogen-flouride laser prototype called Alpha, few experts view the chemical laser as a promising space defense weapon.

Attention next turned to ground-based lasers. They would send beams to relay mirrors stationed 36,000 kilometers above fixed points on the earth, and the beams would be reflected from there down to "fighting" mirrors at about 1,000 kilometers of altitude. The SDIO considered two candidates, both well behind chemical lasers in development. Researchers soon became disillusioned with the excimer laser, which is produced by exciting certain molecules with an electron beam. Because of its in-

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This accelerator at Los Alamos National Laboratory emits a beam of negative ions. The ions, stripped of electrons, form a neutral particle beam (NPB) that can be aimed over long distances. An NPB would require enormous power to function as a weapon. A somewhat weaker NPB might be used to distinguish decoy warheads, but it is far from clear whether this would work. Only basic research on this technology should be funded.

herently low efficiency, it would require very large power generators, and making mirrors that could withstand its intense pulses of ultraviolet light would also be difficult. It is now mainly of interest to the U.S. Air Force for the much less demanding role of an anti-satellite weapon.

The other candidate was the free-electron laser (FEL), first tested only 10 years ago. An electron beam that is caused to "wiggle" in a magnetic field produces the light in an FEL. Such a laser is potentially efficient and powerful, and its wavelength can be adjusted over a wide range to improve transmission through the atmosphere. In 1985 the SDIO portrayed the FEL as the top contender for boost-phase defense, even though research into its potential as a weapon had only just begun. Huge funding—almost $1 billion in 1987 and 1988 alone—was projected for research.

Then the SDIO's priorities suddenly shifted once more. In 1986 support for the FEL slipped and space-based kinetic-energy rockets became the new favorite, on the strength of the interest in early SDI deployment. Ironically, this shift revived a concept that is over 25 years old. In the early 1960s the Defense Department briefly funded, then dropped, a similar project called ballistic missile boost intercept or "Bambi." In 1982, not long before President Reagan announced SDI, High Frontier, a space-defense advocacy group, took up the idea again, but Defense Department analysts rejected the scheme as unpromising.

In late 1986 and early 1987, the standing of the rockets, now called space-based kinetic kill vehicles (SBKKVs), rose dramatically. The Marshall Institute, a pro-SDI study group formed in 1984, issued a report urging deployment in the early 1990s of a defense system featuring 11,000 rockets on 2,200 orbiting battle stations or "garages." Congressional advocates of early deployment quickly championed the Marshall proposal, and it reportedly reflects the general trend, if not the details, of the SDIO's planning.

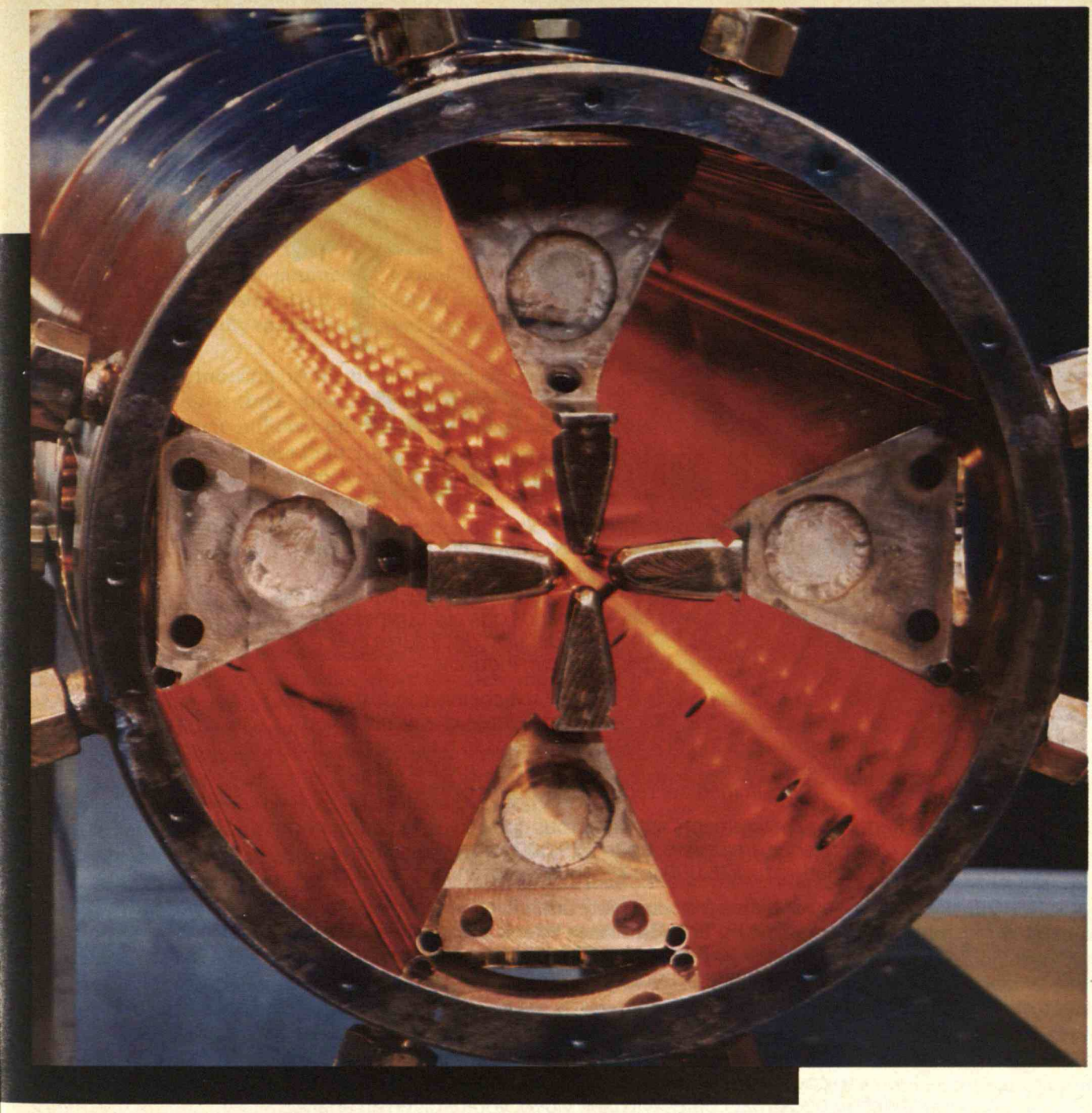
Though officials deny as much, recent SDI budgets show evidence of a shift toward early deployment. Whereas directed-energy weapons were slated to receive 60 percent more funding than kinetic-energy weapons in the administration's original 1987 SDI plan, they received about the same amount in the actual budget. Individual projects reveal the pattern even more strikingly. As recently as last year, the SDIO was planning a 1988 budget of $630 million for the two largest directed-energy experiments, the free-electron laser and the neutral-particle beam. The actual request turned out to be only $300 million. In contrast, the request for space-based rockets and launch technology to lift them into orbit was $738 million, more than double the $329 million planned last year.

Early Deployment

Well over half the SDI budget for weapons and sensors is now devoted to a short list of projects that could lead to a first-generation system by the mid-1990s. In addition to space-based rockets for boost-phase defense, the system would include two types of ground-based rockets to intercept Soviet warheads after they are released. One type would target them in the late "midcourse"—just before they reenter the atmosphere—and the other would seek to stop them in the subsequent "terminal" phase as they drop toward targets on earth. Infrared sensors carried on satellites or launched on rockets would track missiles and warheads by detecting their heat, and radars on the ground would be used as well. No new physical principles need to be understood to make these weapons work, but their prospects for offering an effective missile shield are dim.

The centerpiece of the early-deployment plan, the SBKKV, is a two-stage rocket weighing a few hundred pounds and carrying a vehicle with an infrared sensor to home in on a missile. Five to ten rockets would be carried on each garage, orbiting at between 400 and 1,000 kilometers of altitude to bring the rockets in range of Soviet missiles. The initial deployment outlined by the SDIO would include several hundred garages; a system to stop a large Soviet attack would require several thousand. Upon warning of an attack, the rockets would fire and accelerate to about 5 kilometers per second—nearly 20 times as fast as ordinary rocket interceptors like the Exocet anti-ship missile. Then they would home in on the bright flame of an intercontinental ballistic missile (ICBM) and destroy the missile by hitting it.

The contract to design and test a prototype SBKKV was awarded to Rockwell International only this year, and important technical problems remain to be solved. One is how to locate an ICBM based on



the shape of its flame, since the sensor planned for the SBKKV is not sophisticated enough to detect the missile itself. The hottest point in the flame is below the missile's booster, and the shape depends on the viewing angle, the altitude, and the type of fuel. At high altitudes the flame dwarfs and may even engulf the booster.

The SDIO originally planned to use a sensor able to detect the long-wavelength infrared radiation emitted by objects at roughly room temperature, which would allow a rocket to zero in on a booster rather than its flame. But this sensor was dropped from the initial version of the weapon because developing it would have delayed deployment until the late 1990s. Out of the $75 million 1987 budget for the SBKKV experiment, the SDIO allocated only $5 million to developing the more capable version, thus trading future progress for early results.

In September 1986, the SDIO conducted an elaborate, $150 million test of technologies to track and intercept boosters, called the Delta 180 experiment. Though later touted as having proven the SBKKV's feasibility, the experiment actually fell far short of this—as the SDIO said at the time in response to concerns that it might have violated the ABM treaty. Delta 180 showed that an interceptor could hit the third stage of a rocket by using radar, not infrared guidance. This is relatively easy since the radar beam bounces directly off the booster—not the flame—but radars are too heavy to be placed on a space-based

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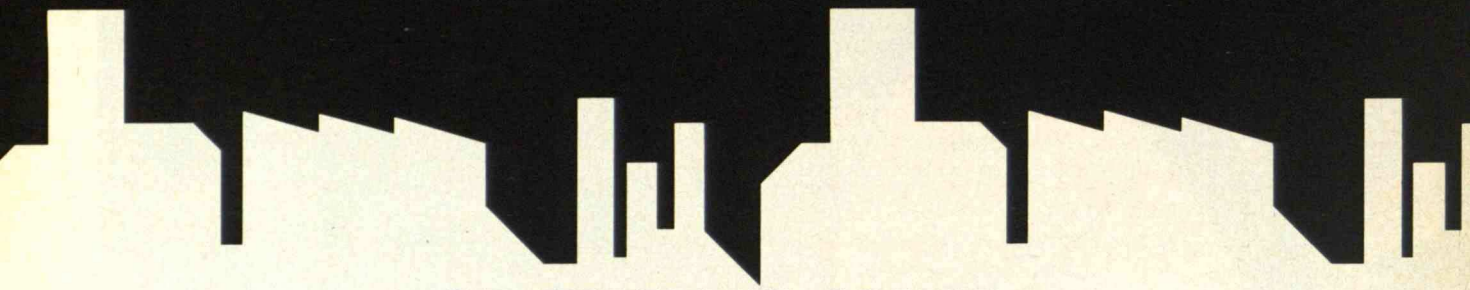

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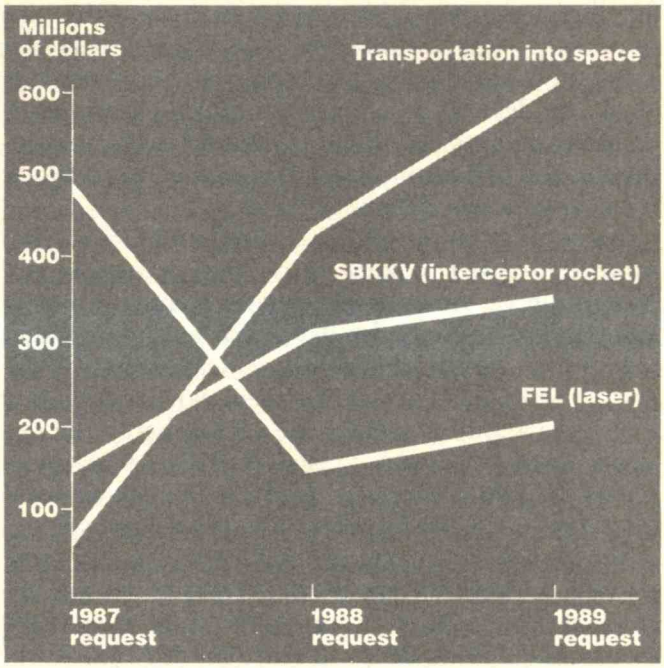
Budget requests for distant prospects such as the free-electron laser (FEL) have declined. Officials are seeking more funds for near-term defense projects, including space transportation and an interceptor rocket known as the "satellite-based kinetic kill vehicle" (SBKKV).



rocket, and they can be jammed or fooled. In Delta 180, the infrared sensor (from a Maverick anti-tank missile) was used only to track a second test rocket's booster flame.

Even if the engineering problems are solved, space-based rockets have three inherent drawbacks that cast doubt on their military utility. First, since the rockets would orbit at less than 1,000 kilometers of altitude, only a small fraction would be in position to fire on Soviet ICBMs at any given time. This "absentee" problem means that a large number of rockets must be deployed for each missile to be intercepted.

The ratio will be about 15 to 1 for the Soviets' missile force of the mid-1990s, if they continue to base their missiles at fields scattered across the country. If the Soviets tightly cluster their missiles, the absentee problem will be even worse—as many as 100 rockets will be required for each ICBM. The defense could not hope to compete with an expanding Soviet offense.

A second problem is that space-based rockets could cover only a limited range during the few minutes available for intercepting boosters before they burn out. By shortening the boost phase of their missiles, the Soviets could give the defense rockets less time and reduce their range still further. As a result, even more would be required to ensure that one would be close enough to strike an ICBM at any given time. Already the Soviets are beginning to introduce solid-fuel ICBMs whose boost phase lasts about three minutes, as opposed to the five minutes characteristic of their existing liquid-fuel missiles. Relatively simple design changes could reduce the burn time to two minutes and double the number of SBKKVs required. A "fast-burn" booster, which would stop firing in a minute or less, would defeat the SBKKVs altogether. They simply could not reach such a booster soon enough.

While conceding that fast-burn boosters would defeat the system, the SDIO downplays the Soviets' ability to develop and produce them at a reasonable price. But both the United States and the Soviet Union have already tested fast-burn technology, in which holes are placed in solid rocket fuel so that a larger surface area burns at one time. Some SBKKV proponents claim that fast-burn missiles could carry only a small number of warheads. One reason is that strengthening rocket casings to withstand higher pressure from the burning fuel would increase the weight of the missile and reduce the available payload. However, studies by Martin Marietta and Lockheed show that the burn time of standard boosters could be shortened to 60 seconds with at most a 25 percent loss in payload.

The third drawback of space-based rockets—and space-based defenses of all kinds—is their vulnerability to attack by Soviet anti-satellite (ASAT) weapons. A particularly simple anti-satellite weapon for the Soviet Union to develop would be the space mine, which would dog the heels of a defensive satellite until ordered to explode. Another option would be to use an interceptor rocket as an anti-satellite device. The United States has in fact already done this in its ASAT program.

As with the fast-burn booster, the SDIO has acknowledged the vulnerability problem only to dismiss it, expressing confidence that researchers will find ways to protect defensive satellites. But this is wishful thinking. Destroying a satellite is easier than intercepting a ballistic missile, since the target follows a predictable orbit and the attacker chooses the time to strike. Moreover, protecting a satellite is harder than protecting an ICBM or its warheads. Cheap decoy satellites, for example, could not fool ground-based radars and telescopes for very long.

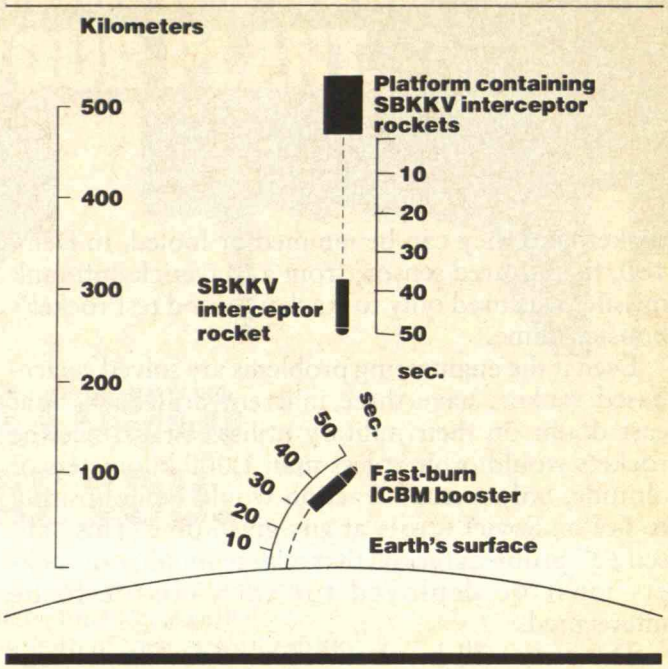
Satellite armor would be impractical, since the tons of added weight would have to be placed in orbit at a cost of more than $1,000 a pound. And when one ASAT can destroy a defensive platform carrying five or more rockets and their associated sensors, computers, and communications equipment, the outlook for cost-effective defense is bleak.

Space weapons would be backed up by two types of ground-based rockets. Midcourse defense would be the job of the exoatmospheric reentry intercept system (ERIS) now under development by Lockheed. ERIS rockets, carrying homing vehicles similar to the SBKKV, would fly out to intercept Soviet warheads that were about to reenter the atmosphere. The terminal defense would consist of high endoatmospheric defense interceptor (HEDI) rockets that would intercept Soviet warheads in the upper atmosphere.

Scheduled for testing around 1990, ERIS is more technically mature than its space-based cousin. Because it would carry more weight than the SBKKV, ERIS could employ the long-wave infrared sensor required to track a warhead that does not produce a hot flame. The June 1984 Homing Overlay Experiment demonstrated that intercepting a warhead is feasible. Still, there are formidable obstacles to making ERIS an economical weapon. The price per interceptor must be cut from tens of millions of dollars to the SDIO's goal of $1 million.

However, the greatest barrier to the success of ERIS is that it could be overwhelmed by Soviet decoys—up to 100 for every real warhead. Without a way to distinguish (and thus ignore) the decoys, which in space would follow the same flight path as the warheads, ERIS would have to shoot at everything. Infrared sensors and radars could be fooled by relatively simple decoys designed to imitate the heat and radar characteristics of actual warheads, or by warheads that imitate decoys. Each decoy would be much cheaper than even a $1 million interceptor. No solution to this problem has been found.

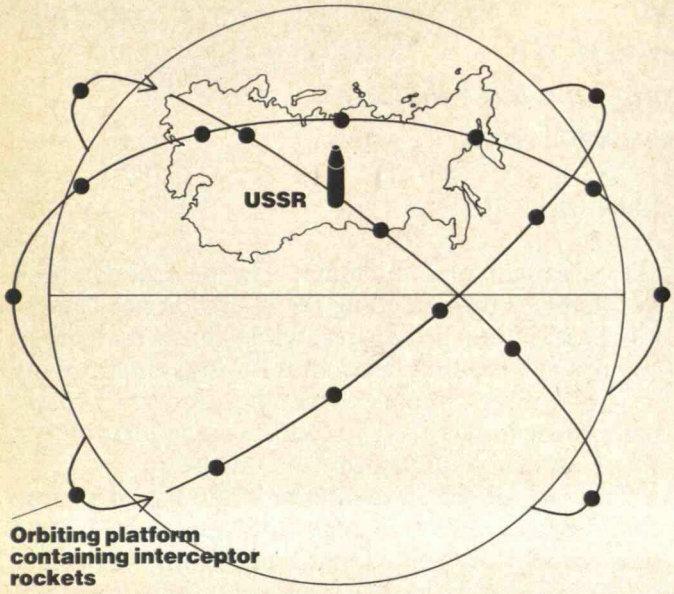
The terminal defense component, HEDI, faces other problems. It trails ERIS in development, largely because it would have less time to intercept its targets and would have to work in the much more stressful environment of the atmosphere. To prevent overheating from atmospheric friction, the window covering the HEDI infrared sensor would be cooled and protected by a shield until a few seconds before interception.



One important question is whether HEDI could intercept warheads high enough in the atmosphere to protect cities, in keeping with SDI's goal. This depends on the altitude at which the atmosphere would retard the lighter decoys enough for HEDI's radar to distinguish them from the warheads. Simple decoys might slow down at about 100 kilometers of altitude, high enough that HEDI rockets could intercept the warheads at a safe altitude of 30 to 40 kilometers. But advanced decoys with rocket thrusters could behave like warheads down to a low altitude. The United States is developing just such decoys, as well as maneuvering warheads, to counter improvements in the Soviet ABM system around Moscow. The Pentagon expresses confidence that it can accomplish the task for a fraction of what the Soviet improvements cost.

Advanced Technologies

Since a first-generation system would provide an imperfect defense against current Soviet missiles and essentially none against improved forces, an advanced second generation would be needed almost immediately. But hopes for a truly effective missile shield rest on directed-energy weapons and sensors, which, as the American Physical Society has concluded, are far beyond present capabilities. According to the APS, a decade of fundamental research is required just to assess their feasibility. Even with a favorable verdict on the weapons, several other problems could still prove insurmountable—for example, managing such a complex system, ensuring the reliability of software that can never be fully



Left: The "absentee" problem means that many rockets would have to be in orbit to ensure that one would be within range of each Soviet missile at any time. Far left: "Fast-burn" Soviet rockets could finish firing in 50 seconds—well before an interceptor could reach them.

tested, and protecting the missile defenses from Soviet attack.

Despite the early stage of the research, the SDIO is concentrating on a handful of directed-energy weapons projects. These include the ground-based free-electron laser (FEL), the space based neutral-particle beam, and the Department of Energy's X-ray laser. The SDIO's goal for FEL research is to build a prototype weapon at the White Sands Missile Range, N.Mex., by the mid-1990s. The prototype would be a 100-megawatt laser that produces light at near-infrared wavelengths of about 1 micrometer (a millionth of a meter). This would be only about one-tenth the power needed for a practical weapon, but it is still far beyond the present capabilities of either of the two designs that it might be based on. The first, being developed at Los Alamos National Laboratory, has achieved an efficiency of only a few percent. Its power must be increased by a factor of 10,000 and its wavelength must be reduced by a factor of 10 to reach the prototype's goal. The second, being developed by Lawrence Livermore National Laboratory, has achieved a remarkably high efficiency of 42 percent, but at an even lower power and at a microwave wavelength 8,000 times larger than the goal.

In pinning its hopes on the $1 billion White Sands project and the enormous Los Alamos and Lawrence Livermore experiments, the SDIO is gambling that several fundamental problems confronting FELs can be solved. The APS report notes that producing shorter wavelengths while increasing the power will be difficult, since the wiggling electron beam must be intensified and focused over a longer distance inside the magnetic field. At shorter wavelengths the FEL may also produce unwanted frequencies ("harmonic" and "sideband" radiation) that would rob the laser of power.

Moreover, the beam of a ground-based laser weapon would have to be pointed with much greater accuracy than has ever been achieved. The low-altitude fighting mirrors must be able to hold a beam 1 meter in diameter on a Soviet booster over 1,000 kilometers away that is traveling at up to 7 kilometers a second. When one booster is destroyed, the mirror must shift to another booster in a tenth of a second. An additional problem is that a laser beam can be distorted by atmospheric turbulence and "thermal blooming"—changes in atmospheric properties caused by the heat the laser itself deposits in air. In experiments in 1984 and 1985, the SDIO demonstrated that mirrors capable of being deformed could correct the beam for distortions, but this was done at such a low power that thermal blooming did not occur. A ground-based laser's power would be near the limit of what could be corrected even in theory, and the task might prove extremely difficult in practice.

The X-ray laser, contradicting SDI's non-nuclear image, would work by channeling the radiant energy from a nuclear explosion into thin rods. They would be vaporized to form a hot plasma whose ionized molecules would produce X-ray radiation. The radiation would be amplified along the axis of each rod, forming beams of potentially enormous power that could be aimed at several targets at once. The relatively light-weight laser could in theory be "popped up" upon warning of a Soviet attack. This avoids the need to base the weapon in space where it would be vulnerable. But the X-ray laser is little more than a concept now. Experimenting with nuclear explosions is an expensive process—each nuclear test costs about $30 million, while the whole project consumes $300 million a year—and project officials say that progress has been much slower than hoped. Although some tests have reportedly achieved "lasing," the efficiency has been extremely low. A weapon would probably take at least 15 years to develop.

In any case, it seems doubtful that the United States would ever deploy the X-ray laser in a missile defense. The technology has inherent limitations for boost-phase defense, particularly if the Soviets de-

The best-understood SDI technologies are not promising, and those that are cannot be fully assessed for years.

ploy fast-burn missiles, since X-rays cannot penetrate the atmosphere down to 80 kilometers, the altitude at which such missiles would stop firing. Perhaps more important, the hair-trigger response time for boost defense would mean relinquishing presidential control over nuclear weapons to a computer. The most likely use for the X-ray laser would be as an anti-satellite weapon, since one device could attack several satellites at once. Ironically, an X-ray laser in this role might well be turned against space-based defenses themselves, with devastating effects.

Space-based neutral-particle beams would be generated by accelerating negatively charged ions to a very high energy, then stripping the extra electrons off to form neutral atoms (probably hydrogen). Neutral beams do not quickly diverge like charged-particle beams, whose particles repel each other. Nor are they bent by the earth's magnetic field. Neutral beams of sufficient energy—for example, hydrogen atoms traveling at about 1 percent of the speed of light—penetrate several centimeters into metals, making it impractical to shield against them.

Originally viewed as a potential defensive weapon, the particle beam is now SDI's main hope for discriminating between warheads and decoys—a job requiring perhaps one tenth a weapon's power. An object illuminated by a particle beam emits radiation (gamma rays and neutrons) in proportion to its mass. By measuring the radiation emitted by a warhead, a sensor could distinguish it from much lighter decoys. The SDIO plans to test this method on the space shuttle in the early to mid-1990s; the total cost of the experiments is expected to be nearly $1 billion.

Although the idea appears feasible in principle, large hurdles need to be overcome before particle beams can be considered promising in practice. Space-based beams would be vulnerable in several ways. The Soviets could attack them, use other particle beams to swamp the detectors with "noise," or detonate nuclear explosions in space to blind the detectors for several seconds. The weight of current devices must be reduced by a factor of 10 before they could be put in space at a reasonable cost, and they must be made far more reliable to operate unattended after years of storage in space. Finally, space-based electric generators to supply the beam with the power it would need—about 100 megawatts, or enough to supply 50,000 homes—have not been developed.

Redirecting SDI

SDI is caught in a dilemma: The best understood technologies for defending the United States against missiles are not promising, while those that might be promising cannot be accurately assessed for many years. In these circumstances, the program's heavy investment in large experiments—some already obsolete and some premature—is unwise.

The task of the next administration is to restore coherence to SDI. Above all, this requires a clearer sense of why the United States needs missile-defense research. Four years of controversy have only obscured the issue, diverting public attention to two strangely opposite goals—the impermeable shield President Reagan envisions and early deployment for its own sake. Neither serves as a useful guide for research.

The U.S. strategic defense research program should focus on less dramatic but more thoughtful objectives. It should hedge against, and thus discourage, the possibility that the Soviets might suddenly renounce the ABM treaty, and it should stay abreast of technological developments that might someday brighten the outlook for an effective missile shield.

The ABM treaty's value to the United States is a great blind spot in current American policy. This much maligned treaty is the foundation of past arms-control agreements and the key to progress at Geneva. It spares us an arms race in which we and the Soviets would compete not only to knock down one another's missiles but also to build more missiles to overwhelm one another's defenses. This was the pattern in the 1960s before the treaty, when in response to the Soviet ABM program, the United States launched its own ABM program and multiplied the number of warheads on its missiles. In response to that, the Soviets put multiple warheads on their missiles as well.

The blind spot is especially puzzling in light of the alarming Soviet ABM "threat" often depicted by U.S. officials. Why does an administration professing such concern about Soviet defenses have such scorn for a treaty that restricts them to a token deployment of 100 ground-based interceptors? The administration's answer is that the Soviets are already preparing to break out of the treaty and the United States is simply responding. This is not convincing. To be

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The apparent premise of U.S. policy is that an arms race in defensive weapons would be to America's advantage.

sure, the Soviet record on the treaty is far from perfect. Most experts agree that the large radar at Krasnoyarsk, probably to provide warning of a missile attack, is illegally located. But few support the administration's claim that the Soviets are poised to deploy a nationwide defense.

On the contrary, it is the United States that is advocating deploying defenses, warning that it will go ahead alone if the Soviets are unwilling to agree. The apparent premise of this policy is that an arms race in defensive weapons would be to America's advantage. Such confidence is misplaced. To trade in the treaty for the sake of SDI testing and deployment would be a poor bargain. A near-term SDI would mainly serve to inspire a Soviet nuclear-arms buildup. A Soviet defense, no matter how ineffective, would create new doubts about American deterrence, reduce our allies' confidence in U.S. protection, and lead to a costly expansion and modernization of U.S. nuclear offensive forces.

Such a scenario is as unnecessary as it is unappealing. To avoid it, U.S. missile-defense research should be steered onto a more responsible course. Fortunately, the dictates of technical and political wisdom reinforce each other here: the same steps that would restore scientific integrity to the program would divert it from its collision course with the ABM treaty.

In a prudent program, research would strictly conform with the ABM treaty. Tests that might violate this accord should be dropped or deferred, and the administration's reinterpretation should be disavowed. We should vigorously pursue negotiations on how to apply the treaty to "exotic" defensive technologies—a critical issue the Reagan administration has refused even to discuss with the Soviets.

Investigation of nationwide population defenses should emphasize basic research rather than advanced development and testing. With its preference for large experiments and early results, SDI threatens to drain the fundamental research on which future progress depends. We should concentrate on make-or-break issues such as satellites' vulnerability to attack, the need to distinguish decoys, and controlling the entire complex system. Unless these issues are resolved, developing specific weapons risks being irrelevant. Moreover, work on the broader problems may yield payoffs outside of missile defense—for example, in computer software or improved sensors for surveillance and arms-treaty verification. On the other hand, the most likely spin-offs of SDI weapons technologies are dangerous new anti-satellite weapons. They would threaten the satellites used for communications and warning of a nuclear attack—vital means for preventing a superpower crisis from escalating into nuclear war.

The United States should do some research on near-term missile defenses—not in order to deploy them but to deter the Soviets from renouncing the ABM treaty with the expectation that they could deploy defenses unilaterally. In contrast to the SDIO's approach, near-term research should center on low-altitude rockets to protect military targets such as land-based missiles and command centers. This was the focus of U.S. missile-defense research before SDI. It is still the most plausible mission, since the defense does not need to be perfect to ensure that enough nuclear forces could survive an attack to retaliate effectively. Also, unlike cities, military targets are already hardened against nuclear blast, and can therefore be protected at close range.

But the administration steadfastly maintains the pretense of population defense on which SDI's public support has been built. Thus, even though SDI supporters justify early deployment as a way to "enhance deterrence"—a code phrase for protecting U.S. nuclear retaliatory forces—they spurn the weapons most appropriate for this role. Low-altitude rockets have been virtually ignored by SDI except as a possible defense against short-range missiles in Europe.

A sensible research program would also pay more attention to ways in which the Soviets could overcome missile defenses. Too often, SDI supporters have refused to consider Soviet countermeasures such as advanced decoys or fast-burn boosters realistically. At best, this leads to exaggerated predictions of how effective missile defenses could be, and at worst it could commit us to a worthless defensive system.

A program conforming to these guidelines would have three great virtues. First, it would save money. For example, cutting the major experiments while continuing fundamental research at planned levels would leave SDI with a 1988 budget of $2 billion to $2.5 billion—less than half the administration's request, but still an opulent budget for a research program. Second, such a program would protect the ABM treaty and improve the chances for large arms reductions. And finally, it would give us a truer picture of the outlook for effective missile defense than the present floundering program. □

CONTINUED FROM PAGE 20

the Export Administration.

This system invites abuse. By proscribing too much, it is often ignored or evaded, and not only by obviously shady companies like Wako Koeki. Toshiba and Konesberg are both well-regarded, legitimate firms. Toshiba Corporation, which owns 50.8 percent of Toshiba Machine, sells approximately $2.4 billion worth of goods to the United States annually. It certainly would never authorize a sale that it thought might threaten such a large volume of exports. Similarly, Konesberg, a major Pentagon contractor, developed and produced an important anti-ship missile that the U.S. Navy once planned to buy but is now reconsidering. Both firms appeared confident that officials, because of overwork, apathy, or whatever, would not notice the discrepancy between the items authorized and the items shipped.

Even before the Toshiba revelations, export controls were the subject of intramural struggle within the U.S. government. Basically, the Pentagon wants to prohibit the export of advanced technology, while the Department of Commerce argues for looser controls. The U.S. business community had been gaining administration support for liberalizing limits on exports, and they were beginning to overcome Pentagon intransigence. The Department of Commerce had already decided to allow the sale of petroleum exploration-and-development equipment to the Soviet Union, exports banned after the invasion of Afghanistan.

A big exposé—which the Toshiba-Konesberg case certainly is—strengthens the Pentagon's hand. Tightening controls, however, only exacerbates the shortcomings of the current system. The scandal has at least highlighted the need to reform export controls. In the Toshiba case, overregulation obscured a substantive violation. Moreover, technology now moves so fast that what is exotic and strategically important today is likely to be mundane and easily accessible tomorrow.

There are lessons to be learned from this incident, not only for Toshiba and Konesberg, but also for COCOM and U.S. officials. Hard as it may be, it is necessary to prune continually the lists of what is strategically sensitive. By all means the United States should deprive the Soviet Union of this nation's most important military technologies, but the rest should be deregulated. That way regulators can concentrate on what is essential. What good is it if we so distract ourselves with those who run red lights that we ignore armed robbers? □

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Jackson Building, Occupancy July, 1987

Biotech Meets Academia, and Transforming the Telephone Network

When Business and Biology Intersect

Biotechnology: The University-Industrial Complex
by Martin Kenney
Yale University Press, $23.95

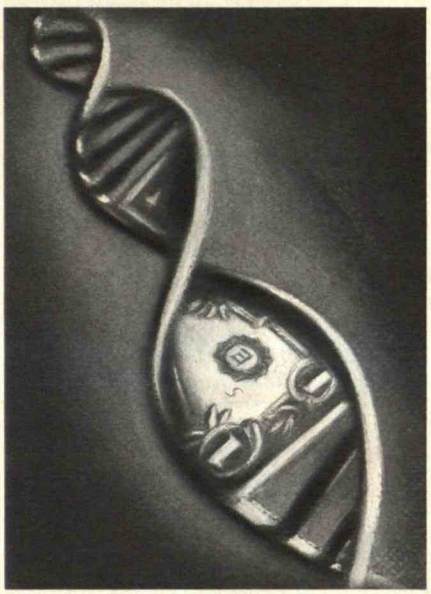
Reviewed by Robert A. Weinberg

Biology is in the midst of a revolution that began just a decade ago. The manipulation of genetic material makes it possible to solve fundamental problems in the life sciences with a rapidity and elegance that could not have been conceived when biotechnology emerged in the mid-1970s.

The recombinant-DNA techniques and scientific paradigms that fuel this revolution have provoked two major debates. The first concerns the safety of these procedures. As the field developed, the public began to fear that genetically altered organisms would prove to be dangerous to humans and wreak ecological havoc. Many observers asserted that the public had a right to know the details of, and ultimately set limits on, research conducted in university and industrial laboratories. This debate has largely quieted as genetic-engineering experiments have proved to be largely if not totally benign.

The other debate concerns the mechanisms through which the technology and its fruits would be transferred from academic laboratories to industry, and ultimately to the marketplace. How would R&D on commercially attractive techniques be funded, and who among the practitioners in academia would sally forth to reap the potentially enormous financial rewards? These questions led to perhaps the most difficult issue of all: How would the growing cooperation between industrial and university researchers affect the integrity of university biology departments, which continue to generate much of the basic research in this area?

In *Biotechnology: The University-Industrial Complex,* Martin Kenney outlines the potential problems provoked by the emergence of hundreds of biotech companies and the rapid commercialization of the fruits of molecular biology. Kenney shows how academic biologists play central roles in many of the young companies, and he chronicles the inroads that these firms and multinational chemical companies have made into universities through support for basic and directed research.



As Kenney points out, the situation is rife with opportunities for compromising the integrity of the research agenda. The lure of sudden wealth can divert the attention of even the most idealistic scientists away from merely interesting problems toward those associated with financial gain. Such a diversion could include professors' entire labs and lead to the involvement of graduate students in research problems whose solution might enhance their bosses' bank accounts.

To pretend that these dangers do not exist would be to ignore the obvious realities of modern biology. Many prominent practitioners of the new biology have both large university commitments and serious involvement in one or more of the burgeoning biotech companies. It is difficult to determine the actual effects of these multiple commitments on scientists' behavior. Kenney argues a worst-case scenario: he maintains that basic molecular research is increasingly converging on the problems of interest to biotech companies. He argues that because the opportunity for corruption exists, it must be pervasive.

Yet my experience in M.I.T.'s Biology Department does not bear out Kenney's scenario. He has apparently made only perfunctory forays into universities to see whether the academic ideal has indeed been eroded. Although almost half the faculty members I work with have some kind of industrial affiliation, they have not shifted the tiller of basic research toward problems of mainly corporate interest. In fact, the exact opposite often seems true. Many researchers have gone far afield from the interests that originally provoked their alliance with industry. In the end, scientists' addiction to unraveling interesting problems has proven stronger than the forces that would induce a shift toward commercial ends.

Feisty Students Vote with Their Feet

Nor have professors exploited their students to an ever-increasing degree. Conflicts in the early 1980s over the use of students and academic facilities for commercial work highlighted these issues and provoked universities to formulate clearer guidelines on acceptable practices. These experiences, combined with the independence of the research trainees themselves, have worked to prevent such abuses. Contrary to Kenney's depiction, graduate students are not helpless chattel, easily manipulated at a professor's whim. They are largely a feisty lot who turn their backs and vote with their feet when they sense they are being exploited. M.I.T. graduate students have recently flocked to the labs of junior faculty working on the developmental biology of flies and worms, this being the most exciting area of research. Few subjects are further removed from the current interests of biotech companies.

Finally, basic biological research has not suffered from a pall of proprietary silence imposed by companies on their allies in academia and in-house researchers. Biotech firms have been eager for their own employees to publish their results to enhance the companies' standings in the scientific community. Indeed, research funded by industry has rapidly become a major source of important new findings in the field. Many companies have also been generous in sharing products and techniques with a wide range of academic researchers, and in arranging collaborations as well.

Kenney patronizingly asks whether we should take an understanding view of biologists and the companies they work with. "Has any industry come into existence unsoiled by chicanery and outright crime?" he wonders. But he fails to document that any crimes have been com-

ILLUSTRATIONS: MARY ANN SMITH

Since the breakup of AT&T, nothing has turned out as expected.

mitted. Scientists and others grappling with solutions to these complex issues are tarred with guilt merely because temptations exist. Biologists deserve a better shake.

ROBERT A. WEINBERG is professor of biology at M.I.T. and the Whitehead Institute for Biomedical Research.

Transforming the Telephone Network

The Deal of the Century
by Steve Coll
Atheneum, $18.95

Reviewed by Pat Aufderheide

Three years after the breakup of AT&T, irascible consumers trying to figure out who to call when the phone won't work are asking: why did they break up the phone company, anyway? And they aren't the only ones who are baffled. Consider that some members of Congress believe that Congress made a mistake in busting up Ma Bell—even though divestiture occurred through an antitrust suit, not congressional action.

Washington Post reporter Steve Coll tackles the formidable job of explaining the ins and outs of divestiture. At book's end he reveals the moral of the story: "Precious little in that history . . . was the product of a single, coherent philosophy, or a genuine, reasoned consensus, or a farsighted public policy strategy. Rather, the crucial decisions . . . were driven by opportunism, short-term politics, ego, desperation, miscalculation, happenstance, greed, conflicting ideologies and personalities, and finally a . . . perceived necessity." According to the author, "If anyone had emerged triumphant from that embarrassing history in how *not* to make public policy, it would have been a phenomenal accident. And no one did."

Coll's list of motivations is typical for high-stakes politics. When the stakes get as steep as they were during the breakup of the world's largest company, it's also important to ask what broader forces underlay individuals' actions, and whether anyone was concerned with ensuring citizens' access to affordable, basic telephone service. But these are not the central questions for Coll. The story he tells focuses on players rather than issues.

The central actors are telephone monopoly AT&T, upstart aggressor company MCI, and officials at various levels concerned with divestiture—Congress, the Federal Communications Commission (FCC), the Justice Department, and the courts.

Although Coll judiciously tries to avoid creating white and black hats, Bill McGowan, who as head of MCI set in motion the antitrust suit that ended in divestiture, comes off as something of a villain. MCI was not the first but the most successful challenger to AT&T's longstanding claim to the right to control the telephone network. In 1969 MCI cannily won the right to piggyback onto this network, and it used this opening to offer customers in lucrative areas cheaper long-distance service. AT&T executives howled that MCI was just "cream skimming"—picking up the easy money while AT&T footed the bill for basic service. But McGowan fought for his corporate life by playing on predispositions against the telecom behemoth, especially among the staff of the FCC and of the Justice Department.

Coll suggests that FCC lawyers gave the new company a break because they had long been suspicious of the giant monopoly that always seemed to have the Defense Department (its most important user) on its side. U.S. District Court Judge Harold Greene, a lifelong liberal who presided over the antitrust suit, also tended to side against powerful interests, including the kind of clout AT&T wielded.

The result, following inconclusive congressional skirmishes, was a legal process that began as a charge that AT&T had failed to offer MCI the services it needed and ended as a reconstruction of the telephone industry. AT&T executives themselves finally forced a last-minute out-of-court settlement of the suit. They gambled on a future in which AT&T would shed the companies that provided basic service and bank on the lucrative long-distance market. They also counted on making significant profits from the marriage of computers and telephones.

New Technology Poses a Challenge

Coll's book is full of juicy details, the best of which reinforce Tolstoy's point about the contingency of history—a letter unopened, an ill-timed vacation, a family illness all suddenly cause events to take a sharp turn in an improbable direction. But a savvy, self-protective shield seems to distance Coll from asking questions about corporate opportunism, commitment to universal phone service, and due process. Even his character sketches are facile rehashes of official biographies, and often include irrelevant data. For example, each scene is set with an obligatory reference to the weather. And qualifying phrases like "the Department of Justice felt" and "Bell's leaders felt" lift the burden of judgment from the author's shoulders.

We learn much from Coll about the "how" of divestiture but not much about the "why." Yet the AT&T breakup was a drama in which individual players rode on waves of technological and ideological change.

Digital technology, especially in switching equipment, opened the gateway for new uses of the telephone beginning in the 1970s, particularly in combination with computers. The phone network is becoming a base for enterprises ranging from banking to data transfer, cable TV to publishing. Many such services, as well as new capacity for businesses, can simply piggyback onto parts of the digital network.

The transformation of telephones into informatics terminals posed new challenges. Should one company control the future of the information economy? Was

The end-user is increasingly being labeled the cost causer.

AT&T's grip on R&D promoting or stifling technological and commercial potential? If services that compete with the local Bell operating companies plug into the network, how do they pay for the access? When the phone company develops new central facilities, who should pay, and in what proportion—individual consumers or the businesses that would be the primary users of the new capacity?

Even though MCI's challenge focused attention on the future of the telephone monopoly, technological innovations would have made change inevitable. AT&T's reluctance to allow MCI to connect to the network—as well as the deluge of indigestible data it foisted on the courts and the armies of employees and well-heeled lobbyists it used to promote favorable legislation—only compounded fears over leaving the future of telecommunications in its hands.

Basic Service Suffers

As technological change accelerated, the political winds also shifted to favor deregulation. Liberals and conservatives increasingly tended to agree that regulation should foster competition—which was supposed to serve the public good—rather than use it as only one tool of many.

These shifts led to an emphasis on "cost-based" pricing in telephone service—efforts to figure out what each element "really" cost. Until divestiture, AT&T followed the course of least political resistance, keeping local rates low and offering new corporate options at a loss while raising long-distance charges. The latter therefore came to be labeled a "subsidy" to local service, even though the long-distance market requires a network of basic subscribers. Since divestiture, the end-user—the individual and small-business phone subscriber—has increasingly been labeled the "cost causer."

The results of these changes have alarmed consumer advocates. According to the Consumer Federation of America, the cost of local phone service has risen 40 percent since divestiture. The federation also points out that lower long-distance charges benefit only the minority of users who make enough such calls to see significant savings. The FCC's own statistics hint that higher phone rates may be taking their toll on universal service: they show a virtual halt in the growth of the number of telephones on the national network since 1980, the year when rates for basic service began to rise dramatically. Those figures suggest that even in the emerging world of new telephone technology, old-fashioned preoccupations with citizens' rights to universal service

Continued on page 78

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may not be outdated.

Since the breakup, nothing has turned out as expected. MCI, like other long-distance competitors, has suffered so gravely from AT&T's regulated price cuts that it now favors deregulating its major rival. AT&T's information wing has bombed in the market, and the corporation survives on its traditional long-distance revenues. The local Bell operating companies are booming: they boast a higher return on equity than other utilities.

Despite Coll's conclusion that no one emerged triumphant from divestiture, the process did produce some winners, the biggest being the monopoly providers of basic service. Yet instability is now the hallmark of the industry, and public policy continues to be made in the absence of guidelines for ensuring universal service.

PAT AUFDERHEIDE is a policy analyst for the Office of Communication of the United Church of Christ.

CONTINUED FROM PAGE 7

sands of U.S. troops using the world's most sophisticated weapons were unable to defeat a modestly equipped but highly motivated communist guerilla force.

COMPUTERS IN DEFENSE

In "Facing Reality: Computer Scientists Aid War Efforts" (*January 1987, page 22*), Joseph Weizenbaum overlooks several facts. First of all, there is often no way to predict the uses for something as flexible as a computer. Should people refrain from inventing altogether on the grounds that whatever they come up with may be employed in war?

Second, while early computers were funded by the military, much has changed. The electronics industry is now more responsive to commercial customers.

Third, I resent the implication that no educated, right-thinking person would work on weapons, or that weapons designers never think about the results of their efforts. I myself feel that the day has not yet come when America can lay down her arms.

KURT WARE
Cambridge, Mass.

Joseph Weizenbaum lags behind most people in realizing that world peace is not possible when some believe in violent aggression. Personally, I'd much rather contribute to the development of advanced efforts to gather information and accurately isolate targets than be subjected to a terrorist incident.

JOHN A. NANGERONI
Goleta, Calif.

I would like to remind Weizenbaum that efficient computer vision could actually minimize wartime destruction: the more precisely weapons can be delivered to military targets, the easier it is to avoid civilian injury or death. The development of extremely accurate, reliable systems would mean that high-yield nuclear devices could be replaced with low-yield devices or even non-nuclear weapons.

WILLIAM H. GANOE
Tucson, Ariz.

ILLUSTRATING THE NEWS

In "The Changing Face of News Graphics" (*February/March 1987, page 10*), Camilia Chavez Cortes has made a slight error in her description of a device known as Harry. The device does not, as Ms. Cortes indicates, combine live video with audio. Rather, it allows the artist to see sequences of recorded video frames and facilitates the editing of these frames in much the same way as a word processor allows a writer to manipulate pieces of text.

Harry can be used with Paintbox and other picture processors but currently has no audio capability. However, technology will soon be available that allows artists to synchronize video images with a sound track.

BILL TOPAZIO
New York, N.Y.

The author responds:

At the National Association of Broadcasters in 1986, Harry's manufacturer, Quantel, demonstrated it with a device that records sound. This device is sold as an option for Harry for $10,000. In addition, Quantel's sister company in the United Kingdom—Solid State Logic—makes advanced audio mixers.

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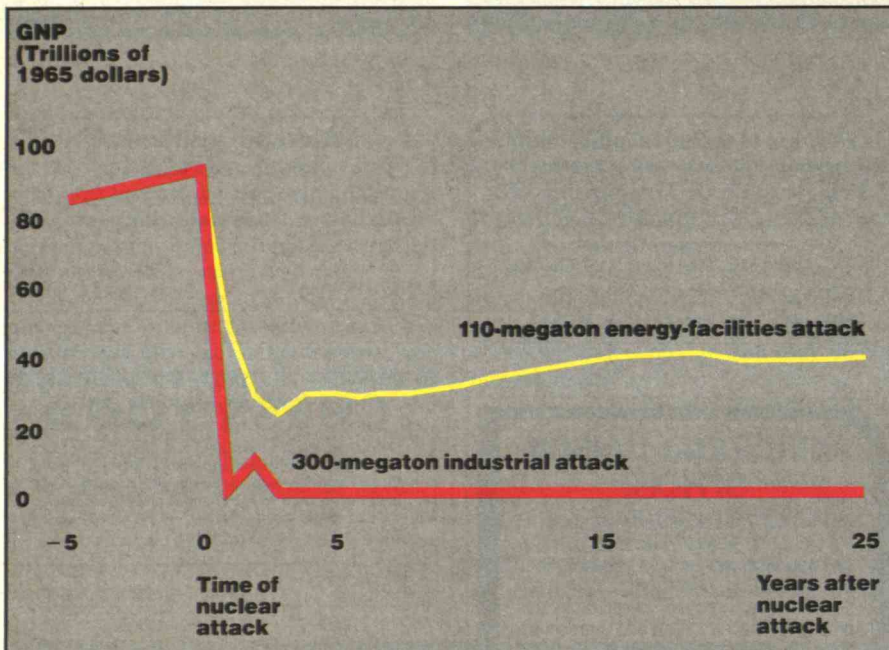
Return to the Dark Ages?



Modeling the effects of nuclear war on the United States, the M.I.T. Program in Science and Technology for International Security concludes that even a minimal Soviet nuclear attack could lead to devastating and prolonged economic disaster. Nuclear bombs with the equivalent of 110 megatons of TNT—about 1 percent of the Soviet nuclear arsenal—could leave the United States without liquid fuels. A 400-megaton attack could permanently destroy the U.S. economy.

The High Price of Nuclear War

A nuclear attack in which the Soviets used but 5 percent of their nuclear stockpile would result in economic devastation from which the United States would never recover—a permanent return to the Dark Ages. Even if the war involved only 1 percent of the Soviets' arsenal detonating in the United States, the results could be economic deprivation for at least the next quarter-century—a nuclear crash.

Since it cannot provide complete protection from a Soviet nuclear attack, the Strategic Defense Initiative is a "worthless expense." Enough bombs to "devastate this country" would surely get through.

These conclusions come from new analyses of the economic effects of nuclear war by the M.I.T. Program in Science and Technology for International Security (PSTIS). The analyses have used an economic model developed by Pugh-Roberts Associates, Cambridge, Mass., for the Federal Emergency Management Agency (FEMA). FEMA says it has abandoned the model as unrealistic, but Kosta Tsipis, director of PSTIS, finds it valid.

The smallest attack modeled by PSTIS was a Soviet attempt to cripple U.S. liquid-fuel facilities with nuclear bombs equivalent to 110 megatons of TNT. Such an attack would cause the greatest economic dislocation possible with so little of the Soviet arsenal, says PSTIS. Destroyed would be every dock and port capable of bringing oil into the country, over 95 percent of U.S. refineries, the strategic petroleum reserve, and major pipelines. Near these targets, some 8 percent of U.S. manufacturing capacity would also be lost; most major cities would be hit by at least one bomb, and about 20 million Americans would die immediately. The major economic damage would result from lack of transport and electricity; continuing food shortages would lead to migration from cities, creating an agrarian economy. GNP would fall by 50 percent in a year, and recovery would be slow and might at best be partial because energy would remain scarce.

A 300-megaton nuclear attack—still only 5 percent of the Soviets' arsenal—targeted on major industries would cause complete collapse; the United States might not "function again as a nationally integrated, independent economy for many decades."

Tsipis and his colleagues—M.I.T. graduate students M. Anjali Sastry and Joseph J. Romm—insist that their assumptions for the FEMA model are conservative. Furthermore, their results make no allowance for the psychological effects that nuclear detonations would surely have—the fact that many people would opt out of a devastated economy by searching for rural self-sufficiency, for example.

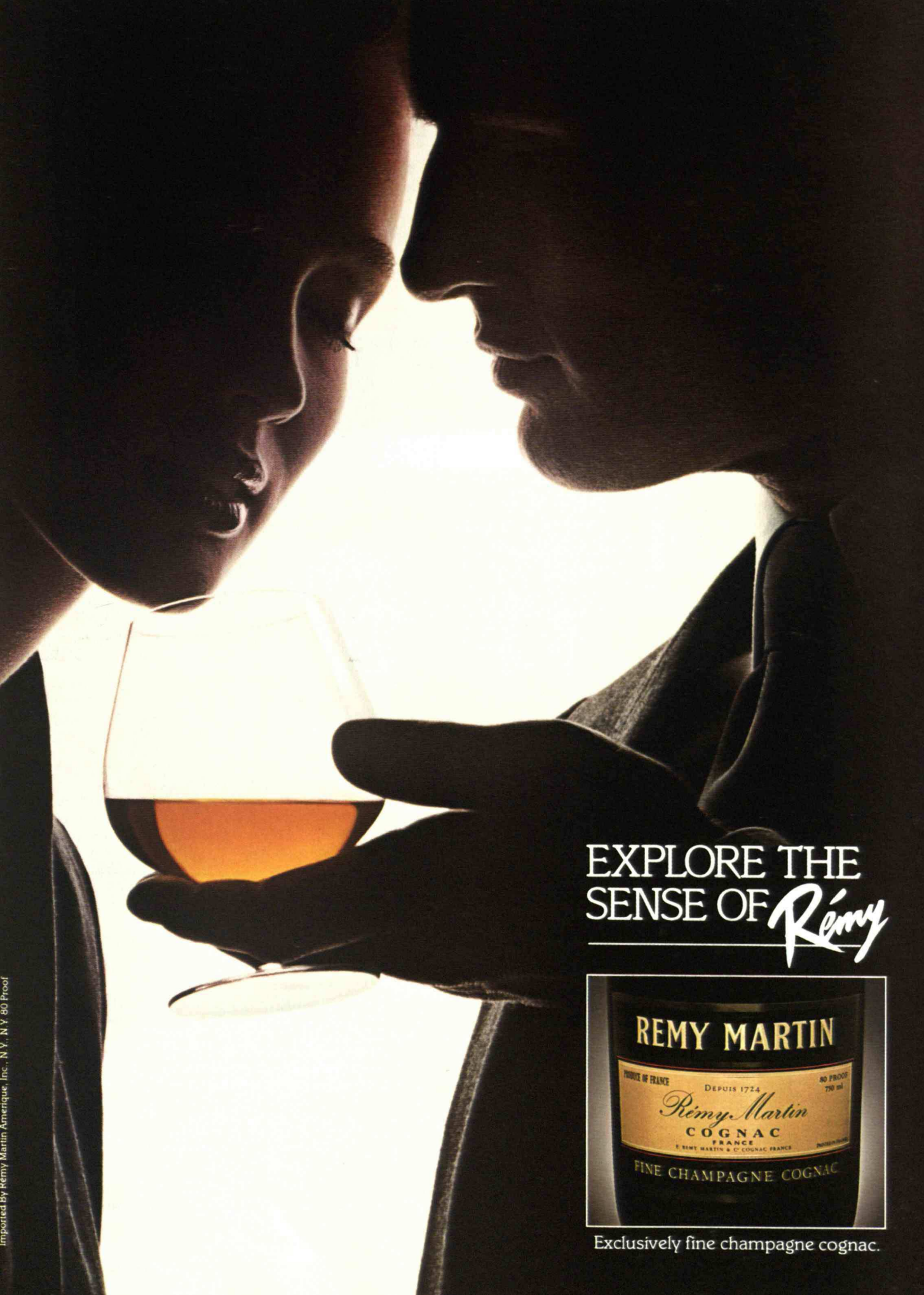
One other side to all of this, says Tsipis. The Soviet economy would be even more vulnerable than that of the United States to a small nuclear attack. Soviet population and industry are more concentrated in cities than ours, food supplies are marginal, and the Soviet infrastructure has minimal redundancy.

Genetic Link to Psychiatric Illness

Scientists at M.I.T., Yale, and the University of Miami reported late last spring identifying the location of a gene that can cause a strong genetic predisposition to manic depression.

Their work is the first indication that molecular genetic techniques can be useful in sorting out the complex factors involved in the onset of psychiatric illness. Biologist David Housman of the M.I.T. Center for Cancer Research, in whose laboratory the genetic studies were carried out, says the research is likely to lead to more effective treatment.

CHART: TOM BRIGGS DESIGN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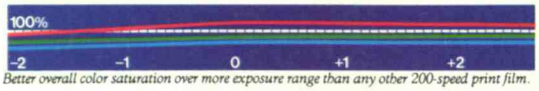

Better overall color saturation over more exposure range than any other 200-speed print film.

Now there's a film that will take you above and beyond your expectations, shot after shot. Kodacolor VR-G 200 film. It's the most vivid 200-speed color print film ever made.

KODACOLOR VR-G FILM

There's no better way to picture your life.

And Beyond.